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Flight Attendant Fatigue

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This report was integrated by the Civil Aerospace Medical Institute from reports prepared by the NASA Ames Fatigue Countermeasures Group.

16. Abstract

The Departments of Transportation and Treasury and Independent Agencies Appropriations Bill (House Rpt. 108-671) included a directive to the Federal Aviation Administration to conduct a study of flight attendant fatigue. The NASA Ames Research Center Fatigue Countermeasures Group (FCG) was contracted by CAMI to conduct the study. To meet the goals of the study, this report contains a literature review on fatigue as potentially experienced by flight attendants, an evaluation of currently used (actual vs. scheduled) flight attendant duty schedules, and a comparison of these schedules to the current CFRs. The report additionally reviews fatigue-related incident/accident information from the Aviation Safety Reporting System (ASRS) and the NTSB database. One report section describes the application of three different performance and fatigue models to assess how flight attendant duty schedules contribute to increased levels of fatigue and predicted changes in performance. The report concludes with 6 recommendations concerning issues that require further evaluation, including: (1) Survey of Field Operations. *To assess the frequency with which fatigue is experienced, the situations in which it appears, and the consequences that follow*; (2) Focused Study of Incident Reports. *To better understand details of the incidents;* (3) Field Research on the Effects of Fatigue. *To explore physiological and neuropsychological effects of fatigue, sleepiness, circadian factors, and rest schedules on flight attendants;* (4) Validation of Models for Assessing FA Fatigue. *An important step to understanding whether and how models could be used in conjunction with field operations;* (5) International Carrier Policies and Practices Review. *To learn how other countries address these issues and with what results;* and (6) Training. *FAs could benefit from information on fatigue, its causes and consequences, its interaction with circadian disruption, and how and when to employ countermeasures (e.g., scheduled naps, physical activity, social interaction, caffeine).*

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EXECUTIVE SUMMARY

The Departments of Transportation and Treasury and Independent Agencies Appropriations Bill (House Rpt. 108-671) included a directive to the Federal Aviation Administration to report back on the subject of flight attendant fatigue. *The following is the language from page 18 of the report*:

> Flight attendant fatigue study: The Committee is concerned about evidence that FAA minimum crew rest regulations may not allow adequate rest time for flight attendants. Especially since the terrorist attacks of September 11, 2001, the nation's flight attendants have been asked to assume a greater role in protecting the safety of air travelers during flight. Current flight attendant duty and rest rules state that flight attendants should have a minimum of nine hours off duty that may be reduced to eight hours, if the following rest period is ten hours. Although these rules have been in place for several years, they do not reflect the increased security responsibilities since 2001, and only recently have carriers begun scheduling attendants for less than nine hours off. There is evidence that what was once occasional use of the 'reduced rest' flexibility is now becoming common practice at some carriers. Because FAA regulations allow the rest period to commence shortly after the aircraft parks at the gate, the eight hour 'rest' period also includes the time it takes a flight attendant to get out of the terminal, go through customs if necessary, obtain transportation to a hotel and check in. Due to this situation, it is likely that many flight attendants are performing their duties with no more than four to six hours of sleep. To better understand the impact of the minimum rest requirements of CFR §121.467 and CFR §135.273, the Committee recommended a study of flight attendant fatigue. This study is to consider professional input from FAA's Civil Aeromedical Institute. The study should be finalized and submitted to the House and Senate Committees on Appropriations no later than June 1, 2005, including the agency's recommendations on potential regulatory revisions.

In response to this directive, representatives of the FAA from the Civil Aerospace Medical Institute initiated an agreement with NASA Ames Research Center to perform an evaluation of the flight attendant fatigue issue. The NASA Ames Research Center Fatigue Countermeasures Group (FCG) is independent of regulatory or advocacy influence and has extensive experience in conducting aeronautical fatigue studies (http://human-factors.arc.nasa.gov/zteam/).

To meet the goals of the study, this report contains a literature review on fatigue as potentially experienced by flight attendants, an evaluation of currently used (actual vs. scheduled) flight attendant duty schedules, and a comparison of these schedules to the current CFRs. The report additionally reviews fatigue-related incident/accident information from the Aviation Safety Reporting System (ASRS) and the NTSB database. One section of the report also describes the application of three different performance and fatigue models currently available as examples to provide the reader with an idea of how flight attendant duty schedules contribute to increased levels of fatigue and predicted changes in performance. The report concludes with recommendations concerning issues that require further evaluation.

Literature Review

Research has identified key findings concerning fatigue in occupational settings where sleep deprivation and disruption of circadian rhythms are known to occur. Among the findings are that such environments can result in an inability to get to sleep (which may lead to further disruption of the circadian rhythm) and to the accumulation of sleep debt. Sleep debt is incurred and continues to build when we obtain less than the recommended 7-8 hours of sleep each night. The results of these potentially cascading effects show themselves in performance decrements. Research for this report found that the main contributing factors to flight attendant fatigue consist of:

Sleep loss has been shown in numerous studies to produce waking neurobehavioral deficits, which include vigilance degradations, increased lapses of attention, cognitive slowing, short term memory failures, slowed physical and mental reaction time, rapid and involuntary sleep onsets, decreased cognitive performance, increased subjective sleepiness, and polysomnographic evidence of increased sleep pressure.

Circadian rhythm disruption is affected by scheduling and sleep disruption. The effects of jet lag and shift work are often characterized by symptoms such as disrupted sleep, changes in mood state, loss of appetite, gastrointestinal disturbance, and disorientation. Sleep loss and circadian rhythms interact dynamically to regulate changes in alertness and performance. Cumulative sleep loss results in sleep debt, with chronic sleep deprivation, night after night, leading to cumulative and progressive performance decrements, even in healthy adults.

Length of duty. End-of-duty sleepiness and fatigue have been reported in flight attendants working both domestic and international flights. Fatigue during international flights is due mainly to flight duration and time zone differences, while fatigue on domestic flights is related to total working hours, landing frequency (number of legs), workload, and layover duration.

Workload. Flight attendants have reported increased perceived stress due to changes in duties and responsibilities since 9/11. The effects of sleep loss, circadian disruption, and scheduling in flight attendants are similar to those experienced by pilots although flight attendants duties are varied and include more physical activity, working in a noisy environment, with higher social involvement.

Schedules

CFRs §121.467 and §135.273 require that flight attendants receive a minimum rest period of nine consecutive hours following a scheduled duty period of 14 hours or less. This rest period may be reduced to eight hours if the subsequent rest period is at least 10 consecutive hours. Further, changes to the rest period can occur when additional flight attendants are scheduled for a particular flight. "Rest period" is not the same as sleep hours, since it includes the time required to travel to and from the airport, time for meals, personal hygiene, and time to relax and go to sleep. The report provides a comparison between *scheduled* on-duty and off-duty layover times and *actual* schedules. The small sample of schedules reviewed were limited and not scientifically based. Overall, our small sample found the duty and rest times were *scheduled* to be compliant with the CFRs, but a small number of the *actual* times extended beyond these limitations when unforeseen operational and weather-related events disrupted the original schedule.

Incident Reports

Seventeen flight attendant fatigue-related incident reports were identified in the ASRS database. ASRS reports cannot reveal the prevalence of the flight attendant fatigue problem; however, they do provide evidence that fatigue is an important issue. Some reports mentioned a lack of adequate rest or meals and listed general symptoms of fatigue. Flight attendants also reported that fatigue had affected completion of critical tasks and expressed a lack of confidence in their ability to handle unusual situations and/or perform adequate security duties.

Fatigue Models

Different biomathematical models of fatigue, sleepiness, and performance are available and could be applied to flight attendants schedules. All models are based on the combination of homeostatic and circadian influences but they differ in the number and nature of the factors that are included. Three models were selected to examine the manner in which they predict fatigue and performance. Although the three selected models differed in particulars, results indicated that they produced consistent results. This analysis was offered as a first step toward the further development and validation of models for predicting flight crew fatigue.

Conclusions

A review of the evaluation materials available for this report has suggested that some segments of this workforce are experiencing fatigue and tiredness and, as such, is a salient issue warranting further evaluation. The Committee on Appropriations (House Rpt. 108-671) suggested that the practice of airlines to schedule closer to the CFR minima on a more regular basis, and very short periods post-flight before the beginning of the rest period may be contributing to this effect. However, the limited nature of the study did not allow us to determine the extent to which scheduling practices either within a single carrier or across carriers were problematic. An additional factor is the difference between the *scheduled* work/rest periods and the *actual* work/rest periods as they play out in field operations**.** Aircraft-related and weather delays as well as other unforeseen operational events contribute to extending a duty period beyond what was originally scheduled.

CFRs provide end points or not-to-exceed levels of regulation. But CFRs do not, and perhaps cannot, capture the multiple variables that impact fatigue and the individual's ability to tolerate fatigue. Taken from the standpoint of just the pre-determined dimensions of the flight itself, the CFRs do not distinguish among the number of segments flown, daytime versus nighttime flights, flights that are uni-meridianal vs. those that are transmeridianal, and regional versus domestic flights.

To truly address the fatigue issue, regulations must be combined with sound and realistic operational practices and supplemented, as needed, by personal strategies. Air travel will always require flexibility in operations in order to adjust to unusual and/or non-routine circumstances. From the standpoint of flight attendant fitness and well-being, consideration needs to be given to the establishment of work/rest practices that take into account the occurrence of unusual circumstances.

This report was developed with data that became available in the short time before the study's deadlines. However, not all the information needed could be acquired to gain a complete understanding of the phenomenon/problem of flight attendant fatigue. Given the nature of the issue and the questions that remain unanswered, the following are a few suggestions offered for continued research to address the topic of flight attendant fatigue.

1. A scientifically-based, randomly-selected flight attendant *Survey of Field Operations*.
2. A fuller understanding of fatigue-related incidents can be achieved by a follow-up *Focused Study of Incident Reports*.
3. *Field Research on the Effects of Fatigue* would explore the impact of rest schedules, circadian factors, and sleep loss on flight attendants.
4. *Validation of Models for Assessing Flight Attendant Fatigue* would be an important step to understanding whether and how models could be used in conjunction with field operations.
5. A study of *International Policies and Practices* to see how other countries address these issues. This study would provide additional data to supplement other on going research.
6. *Training.* Flight crews could benefit from exposure to information on fatigue, its causes and consequences, its interaction with circadian disruption, and how and when to employ countermeasures.

Contents

FLIGHT ATTENDANT FATIGUE

SECTION 1: CURRENT STATUS

Chapter I. Background

The Departments of Transportation and Treasury and Independent Agencies Appropriations Bill (House Rpt. 108-671) included a directive to the Federal Aviation Administration to report back on the subject of flight attendant fatigue. *The following is the actual language from page 18 of the report*:

> Flight attendant fatigue study: The Committee is concerned about evidence that FAA minimum crew rest regulations may not allow adequate rest time for flight attendants. Especially since the terrorist attacks of September 11, 2001, the nation's flight attendants have been asked to assume a greater role in protecting the safety of air travelers during flight. Current flight attendant duty and rest rules state that flight attendants should have a minimum of nine hours off duty that may be reduced to eight hours, if the following rest period is ten hours. Although these rules have been in place for several years, they do not reflect the increased security responsibilities since 2001, and only recently have carriers begun scheduling attendants for less than nine hours off. There is evidence that what was once occasional use of the 'reduced rest' flexibility is now becoming common practice at some carriers. Because FAA regulations allow the rest period to commence shortly after the aircraft parks at the gate, the eight hour 'rest' period also includes the time it takes a flight attendant to get out of the terminal, go through customs if necessary, obtain transportation to a hotel and check in. Due to this situation, it is likely that many flight attendants are performing their duties with no more than four to six hours of sleep. To better understand the impact of the minimum rest requirements of CFR §121.467 and CFR §135.273, the Committee recommended a study of flight attendant fatigue. This study is to consider professional input from FAA's Civil Aeromedical Institute. The study should be finalized and submitted to the House and Senate Committees on Appropriations no later than June 1, 2005, including the agency's recommendations on potential regulatory revisions. (108th Congress 2d Session, HOUSE OF REPRESENTATIVES Report 108-671, DEPARTMENTS OF TRANSPORTATION AND TREASURY AND INDEPENDENT AGENCIES APPROPRIATIONS BILL, 2005, SEPTEMBER 8, 2004, p.18.)

In general, even relatively modest sleep restriction significantly increases sleepiness levels and degrades cognitive readiness and performance (Van Dongen, Maislin, Mullington, & Dinges, 2003). As found in flights, as well as other transportation venues, fatigued individuals suffer from variable and inefficient performance; impaired attention, information processing, and reaction time; reduced short-term memory capacity; and increased involuntary lapses into varying durations of actual sleep episodes (Balkin, Thome, Sing, Thomas, & Redmond, 2000; Dinges, 1995).

FAA/NASA approach to the present committee's concern:

In response to the Congressional direction, representatives of the FAA Civil Aerospace Medical Institute (CAMI) initiated an agreement with the NASA Ames Research Center, Fatigue Countermeasures Group (FCG) that has extensive experience in conducting aeronautical fatigue studies (http://human-factors.arc.nasa.gov/zteam/). The deadline established by Congress for the delivery of the report (June 2005) posed severe limitations on the study design. The team proposed to provide an interim report by May and an addendum report by the end of the fiscal year. Even the extended time frame associated with the delivery of the addendum report limited the extent of the study and as a result, attention was focused primarily on a review of the existing scientific literature on fatigue issues, flight attendants and flight crew, an assessment of existing incident and accident databases, and an analysis of schedules for flight attendants from a small sample of convenience. The limited sample of flight attendant duty schedules were compared with the current CFRs and assessed using three fatigue models to determine potential fatigue states among the schedule examples. The report also provides a description of gaps in current knowledge about flight attendant fatigue, with recommendations for additional issues that should be evaluated with regard to flight attendant fatigue. The NASA fatigue countermeasures group met the established timelines in the delivery of the respective reports and FAA management elected to consolidate both reports into a single document.

Chapter II. Introduction

1. Definition of fatigue

The term "fatigue" has been criticized as a vague multidimensional construct that can be interpreted in a variety of ways (Åkerstedt, Knutsson, Westerholm, Theorell, Alfredsson, & Kecklund, 2004; Dodge, 1982; Hawkins, 1993; Winget, DeRoshia, Markley, & Holley, 1984), the term is now widely used, and in general is understood to reflect the underlying sleepiness/tireness that results from extended wakefulness, insufficient sleep, and circadian desynchrony (Åkerstedt, 1995a). For the purposes of this report, we define fatigue in the aviation environment in terms of its symptoms, which consist of: impaired mood, forgetfulness, reduced vigilance, poor decision making, slowed reaction time, poor communication, nodding off, or becoming fixated, apathetic, or lethargic (Rosekind et al., 1996).

Performance, alertness, and well-being of personnel working in the aviation industry, including flight attendants, are significantly influenced by the presence of circadian rhythms in physiological and psychological processes, by the necessity for shift work duty schedules, extended wakefulness on night flight duty, and the effects of transmeridian flight upon sleep quality and duration and upon circadian rhythmicity in domestic and international routes. These influences reflect 1) the *body's circadian timing system* or the body's internal clock, and 2) the *homeostatic mechanism* or recent sleep history, which includes the amount of time since the last sleep period and the amount of prior sleep (Caldwell, 2005).

2. Bases of fatigue

Circadian rhythms. Circadian rhythms result from cyclic environmental influences (exogenous) or self-sustained (endogenous) oscillations. Circadian rhythms are characterized primarily by phase (time reference point in the cycle), period (time to complete one oscillation cycle), and amplitude (change from the cycle mean value to the peak or trough of the oscillation). Circadian rhythms are primarily synchronized by local light-dark cycles, but also by periodic social synchronizers, which include social contacts and activities (Klein & Wegmann, 1980; Winget et al., 1984). The circadian rhythm results in an increased sleep tendency and diminished capacity to function during early morning hours (circa 0200-0700), and, to a lesser degree, during a period in mid-afternoon (circa 1400-1700; Mitler, Carskadon, Czeisler, Dement, Dinges, & Graeber, 1988). These rhythms peak in the late afternoon (during the day) and trough in the predawn or early morning hours (at night). The body-temperature rhythm, which in shift workers often coincides with performance rhythms (Folkard & Monk, 1985) peaks at approximately 1700 and dips at around 0500. Conversely, melatonin levels, which are inversely-related to alertness (Arendt, Deacon, English, Hampton, & Morgan, 1995) tend to be lowest at 1600 and highest at 0400.

Homeostatic sleep process. The homeostatic mechanism can result in progressive deterioration in alertness and performance, which is superimposed on the circadian rhythmic modulation of these functions (Caldwell, 2005). The homeostatic regulation of sleep and wakefulness is primarily a function of two factors. The first is the amount (and quality) of sleep obtained prior to a given period of performance; and the second is the amount of continuous wakefulness prior to the period of performance (Caldwell, 2005). Sufficient daily sleep, a key component in the homeostatic regulation of alertness, is often one of the first casualties in aviation operations. In general terms, it appears that aircrews suffer from work-related sleep disturbances in the same manner as do industrial shift workers who primarily complain about their sleep patterns or their lack of sleep (Costa, 1997). Insufficient sleep is central to the homeostatically-based drowsiness and inattention that is known to be problematic in work that involves non-standard schedules. Importantly, it should be noted that duty time is not the same as wakefulness. Sleep loss is measured by time awake, not the time one is on duty (Caldwell, 2005).

Continuous wakefulness periods of 19-22 hours on long-haul flights (Nicholson, Pascoe, Spencer, Stone, & Green, 1986) can contribute substantially to aviation crew fatigue (Caldwell, 2005). Wakefulness prolonged by as little as three hours can produce decrements as serious as those found at the legal limits of alcohol consumption (Arnedt, Wilde, Munt, & MacLean, 2001). The consequences of losing even one - two hours of sleep in a single night may result in decrements in daytime function contributing to human error, accidents and catastrophic events (Mitler et al., 1988; Powell, Schechtman, Riley, Li, Troell, & Guilleminault, 2001). Another study showed the physiological alertness of a night shift worker between the hours of 0200-0800 was comparable to that of a day shift worker who had obtained only four hours of sleep for two consecutive nights (National Commission on Sleep Disorders Research, 1993).

3. Scope of the report

Aircrew fatigue is often thought of primarily as a function of scheduling and workload (Samel, Wegmann, & Vejvoda, 1995), and the present report will focus on these issues within the framework of the existing CFRs. Therefore, the primary issues addressed here are on the effect of the duration of work (and to some extent the intensity of workload), the timing of work hours, time zone shifts, and the subsequent impact on off-duty sleep

quality and flight duty performance. However, although other factors such as age, gender, various individual factors, type of aircraft, cabin class, cabin air quality, physical and medical problems, aircraft factors, and personal or domestic situations (e.g., marital status and commuting from domicile location) also may contribute to flight attendant fatigue, these will be noted only briefly since a detailed analysis and discussion of these variables would be beyond the scope of this report because they logically vary regionally and individually. (For a detailed discussion of these issues see: Enck, Muller-Sacks, Holtman, & Wegmann, 1995; Ewing, 1999; Haugli, Skogstad, & Hellesoy, 1994; Hunt & Space, 1994; Nagda & Koontz, 2003; Rayman, 1997; Smolensky, Lee, Mott, & Colligan, 1982; Tashkin, Coulson, Simmons, & Spivey, 1983).

Chapter III. Code of Federal Regulations (CFRs)

Regulations set forth by the FAA for Aeronautics and Space are contained in Title 14 of the Code of Federal Regulations (CFR). CFR §121.467 and §135.273 of Title 14, were established in August, 1994, to provide flight attendant duty period limitations and rest requirements. For the purpose of this report, only the regulations pertaining to fatigue will be discussed. Specifically, on August 15, 1994, the FAA issued a regulation that, for the first time, set the *length of duty and rest requirements for airline flight attendants.* Delays due to litigation resulted in postponement in implementing the CFRs until February 1996.

Overall, the FAA regulatory authority applies when an aircraft is in operation, which is defined as the time when the aircraft is first boarded by a crew member, preparatory to a flight, to when the last crew member leaves the aircraft after completion of the flight, including stops on the ground during which at least one crew member remains on the aircraft (National Research Council Board on Environmental Studies and Toxicology, 2002).

The current regulations (§121.467 and §135.273) require that flight attendants receive a minimum rest period of nine consecutive hours following a scheduled duty period of 14 hours or less. This rest period may be reduced to eight hours if the subsequent rest period is at least 10 consecutive hours. Following a scheduled duty period of greater than 14 hours, but no more than 20 hours, a minimum rest period of 12 hours must be provided. This may be reduced to 10 hours if the subsequent rest period is at least 14 consecutive hours. If the rest period is reduced to 10 hours, the flight attendant may not be scheduled for a duty period of greater than 14 hours during the 24-hour period commencing after the beginning of the reduced rest period. Flight attendants may not be scheduled for duty if they have not had at least the minimum rest requirement. Furthermore, flight attendants must be relieved from duty for at least 24 hours during any seven consecutive calendar days.

A 14-hour duty period may be extended up to 20 hours if the carrier schedules additional flight attendant(s) to the minimum complement required. One additional flight attendant is required above the minimum complement to extend the scheduled duty hours to 16 hours. If two additional flight attendants are scheduled, the duty hours may be extended to 18 hours; and if three additional flight attendants are scheduled, the duty hours may be extended to no more than 20 hours. For example, if the minimum flight attendant complement required for a B757-200 is four, and five flight attendants are scheduled for duty, the scheduled duty period may be extended to a maximum of 16 hours. Table 1 below summarizes the CFRs requirements as related to flight attendant schedules.

The CFRs do not regulate the total number of hours a month a flight attendant is authorized to work, although this is usually defined in collective bargaining agreements. The CFRs also do not focus on the actual hours of sleep obtained between flights, or the timing of the duty periods (in relation to the body's internal clock) despite the fact that these factors are generally considered to be more important than absolute "time on task."

Table 1: *Summarized Flight Attendant (FA) Rest Periods According to the CFRs*

Scheduled Duty Period	Normal Minimum Rest Period	Reduced Rest Period	Subsequent Rest Period	Number of FAs Required
14 hours or less	9 hours	8 hours	10 hours	Minimum
14-16 hours	12 hours	10 hours	14 hours	Minimum +1
16-18 hours	12 hours	10 hours	14 hours	Minimum +2
*18-20 hours	12 hours	10 hours	14 hours	Minimum +3

*Applies only to duty periods with one or more flights that land or take off outside the 48 contiguous States and the District of Columbia.

Note: Generally, off-duty time begins no less than 15 minutes after the aircraft pulls into the gate and continues until one hour prior to a flight attendant's next departure.

SECTION 2: U.S. FLIGHT ATTENDANTS

Chapter IV. Flight Attendant Responsibilities

1. General

A study and extensive task analysis of flight attendant duties was conducted by Damos Aviation under contract with the Association of Professional Flight Attendants (personal communication, Patt Gibbs, March 4, 2005) however, this information was not available and could not be included in this report. A discussion based on a literature review is provided below.

As cited in the National Research Council Board on Environmental Studies and Toxicology (2002), the number of flights and the fraction of seats occupied (load factor) has risen, and seats are more densely packed, particularly in economy class. "Between 1986 and 1999, the load factor for U.S. carriers serving domestic and foreign locations increased by about 13% and 21%, respectively. And from 1986 to 1998, the average U.S. domestic trip length increased from 767 miles to 813 miles, and the average foreign trip length increased from 2,570 miles to 3, 074 miles (AIA, 2000)." Flight stages have steadily increased since 1950, particularly on international flights with nonstop flights of 12-14 hours now being commonplace (Hunt & Space, 1994). In terms of flight workload, CFR §121.391 specifies that at least one flight attendant is required in an aircraft with a seating capacity of 9-50 passengers, two flight attendants for 51-100 passengers, and one additional flight attendant is required for each unit of 50 extra seats.

Flight attendants' responsibilities, including workload duties and their respective changes (especially increases due to 9/11), can be traced for several decades. For example, on international flights before World War II, workload duties lasted from 16-24 hours, depending upon weather. The flight attendants were required to check passports, prepare formulas for infants, care for children, pass out reading and writing material, make up berths for 16 passengers, serve up to three complete meals, and wash dishes if additional meals were necessitated by weather delays. Therefore, it was not uncommon for a flight attendant to work up to 25 hours without sleep (Alter & Mohler, 1980). Examination of current flight attendants' duties reveals that their workload incorporates multiple tasks, consisting of considerable walking, bending over, heavy lifting and pushing, and dealing with a variety of stressful situations in the cabin. Further, flight attendants' duties encompass pre-flight, flight, and post-flight tasks (For a full description of flight attendant duties, see Appendix 1). On average, a flight attendant arrives one to two hours before flight and then, among other activities, is responsible for:

–**During pre-flight:** checking company e-mail, attending a pre-flight briefing, checking all emergency and other equipment, monitoring passenger access and seating, assisting with the stowing of luggage, arming doors, and filling out and providing the flight crew with relevant paperwork.

–**During routine flights:** attending to passenger safety and comfort. Flight attendants provide safety instructions; enforce safety rules; prepare and serve food and drinks; distribute pillows, blankets and magazines; work audio and video equipment; collect trays, glasses, newspapers and the like; answer passenger questions; and communicate as needed with the flight crew.

–**During non-routine flights:** depending on the emergency, flight attendants must notify the cockpit of malfunctioning equipment or emergency situations, deal with ill or disruptive passengers, operate first-aid or other medical equipment, distribute medication, operate emergency equipment, instruct passengers on emergency landings, direct the evacuation of passengers, and the like.

–**During post-flight:** disarming doors, deplaning passengers, checking and tidying the cabin, reporting cabin discrepancies to the flight deck crewmembers, and reporting to operations for company e-mail and other instructions.

As indicated above, flight attendants are required to perform a number of physically demanding tasks. Many flight attendants report that they spend most of their flight time on their feet. But they are also challenged emotionally, e.g., by requirements to perform multiple tasks on a tight schedule, and by being the POC that all passengers look to for information, help, and support. In short, one of the stressors of flight attendants is that they are always "on".

But surely the greatest challenges are related to ensuring safety and especially responding to a non-routine situation. It is here that the abilities, skills, and training of the flight attendants are most challenged and where one would expect the effects of other stressors such as fatigue and circadian dysfunction to have the greatest impact.

Historically, the number of flight attendants in service has greatly increased and the diversity of the flight attendant population has significantly broadened. But this has changed recently with contractual reductions of flight attendant/passenger ratios to the CFR floor in the 1990s. Therefore, the effects of workload and fatigue upon flight attendants in the current workforce should take into account age and sex differences, and personal

issues, such as family responsibilities, as well as other factors such as the impact of cabin qualities (noise and air quality) physical responses (dehydration and sinus congestion), and flight and duty times.

2. Flight attendant responsibilities, fatigue and the issue of post 9/11

Although scientific studies documenting flight attendant workload post 9/11 are not available, there are anecdotal reports indicating that the workload for flight attendants has increased. For example, prior to 9/11 passenger disruption was reported to be the number one complaint submitted by flight attendants to the Aviation Safety Reporting System [ASRS], (Connell, Mellone, & Morrison, 2000). According to that study, one-fourth of passenger disruptions resulted in a cockpit crewmember leaving the cockpit to help resolve the situation. Since recent security regulations require cockpit crews to secure and remain in the cockpit, the flight attendants have to deal with problem passengers without help from the cockpit crew.

It can also be presumed that at a minimum security duties would include closer inspection of passengers as they board, greater vigilance and monitoring of passenger behavior during flight, and a sweep of the aircraft cabin before and after each flight leg. It has also been suggested that the behavior of flight attendants vis-à-vis passengers has changed since 9/11. Flight attendants are showing more concern for and attention to meeting passenger needs. Passengers are arriving at the aircraft more harried and annoyed than previously, and the flight attendants appear to be trying to compensate. Although helpful to the passengers, this added attention places additional workload on the flight attendants.

While these examples make it apparent that an increase in flight attendant workload has probably occurred, these particular issues were not specifically addressed in this study.

Chapter V. Background Literature on Flight Attendant Fatigue

1. Literature Review

The literature review concerning flight attendant fatigue and associated relevant factors incorporates information from scientific publications, including experimental studies and survey reports. It additionally includes information from other articles, websites, and sources. In reporting this literature we have made an effort to evaluate the validity and reliability of the information presented, and to include only those that appear to be the most objective, unbiased, and relevant.

It should be remembered that, from a scientific perspective, the fatigue literature has certain limits. These limits are not unique to the fatigue area but are general across domains. Experimental studies tend to be limited by small numbers of participants and often include non-representative subjects (i.e., some studies were not conducted with flight attendants). Also, questionnaires and surveys may be limited by self-selected respondents or by low response rates. Media or website reports tend to be anecdotal, and reports from many sources lack peer review. However, taken together, these studies provide a considerable base of information that cannot be obtained any other way. By selective screening, these data can broaden our understanding of, and approach to, managing flight attendant fatigue.

Sleep loss effects

In a study of progressive sleep loss effects over an extended period, adult participants receiving less than eight hours time in bed each evening, demonstrated neurobehavioral performance deficits, i.e., lapses in attention on a simple reaction time test (Van Dongen et al., 2003). The performance deficits seen from chronic sleep restriction of six hours per night over an extended period was equivalent to performance deficits seen after two nights of complete sleep deprivation. This study also showed that chronic sleep restriction resulted in a significant increase in subjective sleepiness. In a survey of 3412 flight attendants (Smolensky et al., 1982) fatigue was found to be five to 7 times higher in flight attendants who slept poorly, felt emotional pressures, and worked multiple day trips. Accumulated sleep loss becomes a sleep debt towards the end of a workweek, leading to increased sleepiness (Roehrs, Carskadon, Dement, & Roth, 2000).

Fatigue can be measured objectively by assessing physiological levels of sleepiness (e.g., electroencephalogram (EEG); simple reaction time tasks) or subjectively with questionnaires. Subjective levels of sleepiness may be masked by factors such as environmental stimulation, physical activity, or caffeine, thus making it difficult to estimate one's sleepiness or alertness level. Although physiological levels of sleepiness tend to co-vary with subjective levels of sleepiness (Van Dongen & Dinges, 2000), research has demonstrated that individuals cannot be relied upon to self-detect neurobehavioral impairment due to fatigue (Leproult, Colecchia, Berardi, Stickhold, Kosslyn, & Van Cauter, 2003). Some physiological and cognitive changes that may occur as a result of fatigue include microsleeps (brief intrusions of EEG indicators of sleep greater than 5 sec), lapses in attention (reaction times greater than 500 milliseconds), slowed reaction time,

increase in errors, short-term memory impairment, lack of situational awareness, and impaired decision making (Caldwell, 2005).

Several studies have documented the degree that sleep loss is associated with performance decrements equivalent to the consumption of the legal limit of alcohol (0.05% -0.1% blood alcohol levels; Dawson & Reid, 1997; Lamond & Dawson, 1999; Williamson, 2000). Wakefulness prolonged by as little as three hours can produce performance decrements (Arnedt et al., 2001), while the consequences of even one to two hours of nightly sleep loss over a week may result in decrements in daytime function leading to human error, accidents, and catastrophic events (Mitler et al., 1988; Powell et al., 2001). Monk (1980) showed that layover sleep for aircrew on international flight schedules was disrupted and truncated to durations below their sleep times at home.

Workload

In terms of flight workload, 14 CFR §121.391 specifies at least one flight attendant is required in aircraft with seating capacity of 9-50 passengers, two flight attendants for 51-100 passengers, with an additional flight attendant required for each unit of 50 extra seats. The only other set of specifications obtained for flight attendant complement was from the Australian flight regulations, which pertain to flight attendant complement on charter and public transport aircraft. These regulations provide that a flight attendant is required for 15-36 passengers; aircraft carrying 36-216 passengers shall carry a flight attendant for each unit of 36 passengers; aircraft with more than 216 passengers shall have not fewer than one flight attendant for each floor level exit in any cabin with two aisles (for more information on the Australian Civil Air Regulations, please refer to www.aph.gov.au/senate/committee/rrat_ctte/completed_inquiries/2002-04/civilaviation_nz/submissions/sub2.doc).

In recent years, there have been many changes in commercial aviation that have affected duty cycles and workload. Meanwhile, the scientific understanding of the impact of work hours, sleep, and circadian factors has advanced considerably as well. One of the present concerns is that the associated regulations designed to manage flight crew fatigue have not kept pace with these changes (Caldwell, 2005).

In a number of studies the amount of walking that occurs during duty hours has been shown to be related to workload intensity and duration. Fatigue was attributed to workload by 58% of flight attendants in a study conducted by Smolensky et al. (1982). In a recent study by Morley-Kirk and Griffiths (2003), generally, high workload demands were reported by 83% of flight attendants. On-duty walking distance was reported to be greater than their off-duty walking distance and was significantly correlated with length of the duty day, the end-of-duty stress level, and reported fatigue. In another workload-related study with 118 female flight attendants (Hagihara, Tarumi, & Nobutomo, 2001), the number of walking steps was measured with pedometers during international flights. The total average number of steps taken per flight attendant during flights of an approximate duration of 10.6 hours was 10,742.8, or 14.0 steps/min. Another study found length of duty day had significant effects on end-of-duty sleepiness and upon fatigue levels in both international and domestic flight attendants, and also on end-of-duty stress for domestic flight attendants (Galipault, 1980).

Several researchers also report that for international flight attendants, end-of-duty fatigue is proportional to the percentage of cabin occupancy (Galipault, 1980). Each cabin-type served, had an impact on cabin crew well-being and fatigue. For example, task loads are especially high in the economy class and was associated with lower well-being than business cabin (Morley-Kirk & Griffiths, 2003). Vejvoda et al. (2000) evaluated physiological and workload stress in 44 flight attendants during transmeridian flights working in first, business, and economy cabin classes. They found that the flight attendants working in economy class had higher blood pressure levels, and incidences of heart rates greater than 120 beats/min, compared with the flight attendants working the other two classes. Flight attendants working in business class also showed heart rate increases greater than those working first class. Those working in economy class had significantly shorter sleep periods during the transmeridian flights, suggesting that their work periods limited the opportunity to nap. Also, the relatively higher physiological and subjective work stress measures reported by the flight attendants working economy class were attributed to higher workload demands (Vejvoda et al., 2000).

Flight duration and type

Several studies have examined the question of the amount of time a flight attendant has to be on duty before fatigue sets in. In one study (Simonson, 1984) the majority of flight attendants set the fatigue range as between six and 10 hours. However, 21% were not fatigued until completing 11-15 hours of duty. In a second study (Galipault, 1980) the duty length that flight attendants thought induced tiredness ranged from four hours (10%), to five - six hours (51.1%) up to seven - nine hours (27.6%). This study also found that short duration flights with beverage or snack service produce large increases in end-of-duty fatigue.

International vs. Domestic. Flight attendants on international routes are more likely to be older and have higher tenure than flight attendants on domestic routes. MacDonald, Deddens, Grajewski, Whelan, and Hurrell (2003) found that international flight attendants reported lower ratings of fatigue effects than domestic flight attendants. The domestics experienced very high correlations of fatigue with age, start and end-of-duty stress, sleepiness and pulse rate. Job strain and fatigue was significantly higher among domestic flight attendants, who had higher job demands. It is interesting to note that in this study, the international flight attendants reported less stress and sleepiness than domestic flight attendants despite reporting nearly twice as many average hours of commute times. International flight attendants are provided with a rest opportunity during the cruise portion of the flight. Even though any sleep achieved may be less than optimal (turbulence, noise, crowded conditions), it is nonetheless more restorative than no sleep at all. Older flight attendants on domestic flights were found to have greater fatigue effects resulting from multiple flight legs than younger flight attendants (MacDonald et al., 2003).

A survey of 211 female flight attendants assigned to nonstop international flights (Ono, Watanabe, Kaneko, Matsumoto, & Miyao, 1991) revealed that fatigue complaints increased after the second meal service (seven- ten hours after takeoff). Among the different flights, differences in fatigue levels were attributed to length of the flight, the time zone differences, and the possibility for adequate rest during the layover. In domestic operations, increased fatigue was associated primarily with elapsed working hours, landing frequency, and the number of consecutive duty days.

Long Haul vs. Short Haul. A survey of 190 flight attendants (Nagda & Koontz, 2003) showed that tiredness and lack of energy were higher in response to long haul (52.8%, 22.8%, respectively) than short haul (31.7%, 12.7%) and ground control (35.0%, 9.0%). The most common physiological symptom associated with long-haul flying is sleep disturbances, including difficulty falling asleep, spontaneous night awakenings, and early morning awakenings (Samel & Wegmann, 1989). A number of studies of flight attendants have found that fatigue symptoms associated with factors such as disruption of circadian rhythm are exacerbated by longer flight durations. Nagda and Koontz (2003) found that the frequency of symptoms related to circadian rhythms increased with longer flights, rapid changes in time zones, and early morning or late night flights. Haugli et al (1994) reported that the largest percentage differences between long (LH) and short hauls (SH) occurred in the sleep and mood problems, with sleep problems in 27.7% (SH) versus 61.6% (LH), fatigue in 52.9% (SH) versus 74.1% (LH), easily tired in 29.5% (SH) versus 42.3% (LH), and irritability in 23.6% (SH) versus 43.1% (LH).

Boeing and Airbus have established new ultra long-range aircraft capable of flying extended non-stop flights such as 18 hours and 30 minute flights from Los Angeles to Singapore. These ultra long flights will clearly increase the potential for decreased alertness and performance efficiency in the flight attendants assigned to duty on these routes (Mallis, Colletti, Brandt, Oyung, & DeRoshia, 2005).

Shift work. An examination of flight attendant schedules reveals that in many ways, flight attendants face fatigue factors similar to those encountered by industrial shift workers. Shift work is defined as any non-standard work schedule (e.g., evening or night shifts, rotating shifts, split shifts, and extended duty hours) in which most of the hours worked are outside the period between 0800 and 1600. In shift workers, night work is often performed at or near the trough or minimum of the circadian rhythms in performance and alertness, and the sleep-wake cycle is often desynchronized from the external day-night cycle and from the prevailing social interaction cycle (Holley, Sundaram, & Wood, 2003). Shift work results in a state of almost permanently conflicting synchronizers, and therefore re-adaptation during shift work may be slower and less complete than after time zone flights (Samel & Wegmann, 1989). A major ramification of shift work is sleepiness and unintentional sleep (Åkerstedt, 1995a, 1995b).

Mental performance changes from 10 to 30% over a 24-hour period and follows the circadian cycle (Klein & Wegmann, 1980). However, some field studies have shown considerably larger shifts associated with fatigue related to continuous duty, with oscillations from mean performance up to 100% (Klein & Wegmann, 1980). In examining subjects who had consumed the legal limit of alcohol (0.1% blood alcohol), Dawson and Reid (1997) found 11.6% shifts in mental performance, while Lamond and Dawson (1999) found a range of 14% to 49% in the same measure. It is apparent that performance decrements equivalent to consuming the legal limit of alcohol occur with circadian disruption in field operations - ***even without the loss of sleep.***

In general, operating near the trough of the circadian cycle has been associated with a significantly high incidence of accidents. For example, single vehicle auto accidents present a major peak from midnight to 0700, especially between 0100-0400, with a small secondary peak between 1300-1600. The peak time for single vehicle truck accidents is between 0100- 0700. Another study found similar results with a major peak in errors occurring between 0200-0400 and a minor peak between 1400-1600 (Mitler et al., 1988). Additionally, shift work

schedules have been found to disrupt physiological circadian rhythms, disturb sleep-wake cycles, contribute to physical and psychological problems, as well as social and domestic problems (Barton, 1994).

Flight attendants, like other shift workers, suffer from desynchronized circadian rhythms along with associated sleep disruptions and performance decrements. Unlike the usual shift worker, flight attendants are often in new environments, attempting to sleep in unfamiliar beds, and generally away from their at-home routines.

Transmeridian flights

In the aviation operational environment, sleep cannot be taken at the time of the usual or optimal circadian phase due to the mismatch between the internal circadian clock and external synchronizers, and due to night flights and irregular duty hours. This mismatch results in increased fatigue, sleepiness, acute and accumulative sleep loss, and performance decrements (Graeber, Dement, Nicholson, Sasaki, & Wegmann, 1986; Klein & Wegmann, 1980; Samel & Wegmann, 1989; Winget et al., 1984). Sleep problems are exacerbated when aircrews have to operate multiple transmeridian flights in close succession (Sasaki, Kurosaki, Spinweber, Graeber, & Takahashi, 1993).

Rapid time-zone transitions result in a phase shift between the circadian rhythms of an individual as he/she embarks on a trip and the external environmental synchronizers of the destination environment. A phase shift means that a reference point (rhythm phase or timing of an environmental synchronizer) has been advanced or delayed in time, while the rhythm period length remains constant. The resulting disruption of circadian rhythmicity has been described as "jet-lag", rhythm desynchronization, dysrhythmia, or desynchronosis (Winget et al., 1984). A study of long distance travelers (Criglington, 1998) using a major U.S. carrier and major international airline, found that 94% suffered jet-lag symptoms and 45% considered their symptoms severely bothersome. The jet-lag symptoms included tiredness over the first five days after arrival (90%), interrupted sleep after arrival (93%), and lack of motivation and energy (94%). In a different study (Vejvoda et al., 2000), jet-lag symptoms were reported by 80% of flight attendants with 22% reporting severe symptoms. The most difficult flights were continuous short-haul flights. Coping mechanisms were often inappropriate and included use of alcohol or anxiolytic drugs to induce sleep (Sharma & Shrivastava, 2004). An earlier survey including 3412 flight attendants, linked a combination of excessive fatigue and mental exhaustion to sleep problems in 63.1% of this sample. Over 71% felt fatigued during flights at least three - four times during a 30-day span and only 9.1% felt no fatigue. Time zone travel also resulted in moderate to severe sleep problems in 78.1% of respondents (Smolensky et al., 1982).

It should be remembered that performance deterioration can result from circadian rhythm disturbances and not solely from sleep loss. Moreover, the circadian minimum in alertness and performance sometimes occurs in flight, at which point the chances of performance error are high (Holley et al., 2003).

Number of zone changes. The degree of deterioration in sleep duration and quality and in performance efficiency is dependent upon the number of time zones crossed. Fatigue levels increase to critical levels during 9-time zone flights after eight hours of flight time (Samel et al., 1995.) However, performance deterioration may occur in response to only a one-hour time change (Monk, 1980). Sleep quality and recovery is also dependent upon the number of time zones crossed. The response to crossing 10 times zones was found to be significantly worse in terms of sleep quality, adaptation, and days needed for recovery than crossing seven time zones (Suvanto & Ilmarinen, 1987c). Sleep quality, perceived adjustment and perceived recovery times were all longer after 10 time zone changes and eastward flights than after seven time zone changes heading westward (Suvanto, Partinen, Harma, & Illmarinen, 1990).

Transmeridian flights across nine time zones with short (50 hour) layovers resulted in reduced sleep efficiency during the layover, which was characterized as too short and disturbed by awakenings. Recovery sleep during four post-flight days was characterized by difficulties waking up and feelings of not being refreshed from sleep (Lowden & Åkerstedt, 1998). In a study of aircrew (including 35 flight attendants) sleep on an eight time-zone trip flight from Stockholm to Tokyo with a short (51 hour) layover, it was found that the outbound flight day was characterized by 21 hours of wakefulness, during which sleepiness was elevated. Sleep lengths did not vary significantly but sleep efficiency was significantly reduced on both nights abroad and during the first recovery sleep. Night sleep abroad was reduced in sleep quality, contained more awakenings, and was characterized as less calm and refreshing. On the first free day in Japan, the subjects showed severely reduced alertness during a quarter of the day. Periods with severe sleepiness were more common on the homeward flight (Lowden & Åkerstedt, 1999).

Eastbound vs. westbound flights. Fatigue effects have been found to be dependent on flight direction. Eastbound flights result in significantly more fatigue than westbound flights. Resynchronization is 50% faster following westbound flights, with a rate of 88 min/day for westbound, and 56 min/day for eastbound flights. For example, the psychomotor performance rhythm requires

three days to achieve 95% adaptation after westward flight, but requires eight days after return from eastward flights (Klein & Wegmann, 1980). Eastward transport was characterized by significantly worse sleep quality, adaptation, and recovery time than westbound flights, (Suvanto & Ilmarinen, 1987b). An increase in subjective fatigue during the second part of eastbound flight has been found to coincide with the observed circadian trough and period of increasing sleep deprivation (Samel & Wegmann, 1989). Lowden and Åkerstedt (1999) have found westward flights to be associated with extended wake spans during layover, increased sleepiness, and slow recovery on return home. Eastward flight was associated with longer sleep latencies, worse sleep quality, more difficulty arising, and more severe sleepiness during time awake.

The east vs. west effects of 4-day, round-trip transmeridan flights across 10 time zones (Helsinki to Los Angeles, return flight Seattle to Helsinki) on the salivary melatonin and cortisol levels in 35 female flight attendants has shown that the resynchronization rate of these hormones after westward, outgoing flights was faster than the resynchronization rate after eastward return flights (Harma, Laitinen, Partinen, & Suvanto, 1993). Klein and Wegmann (1980) found that resynchronization times to vary from 1.7-6.0 days (westward) to 2.9-11.3 days (eastward).

The impact of the direction of flight is compounded by day/night relationships. Samel et al. (1995) report that westbound flights are typically scheduled as day flights, while eastbound flights are more typically night flights. Nighttime flights have been associated with greater sleep loss and sleep disturbance than day flights (Gander, Gregory, Miller, Graeber, Connell, & Rosekind, 1998; Samel, Wegmann, & Vejvoda, 1997). In a study in which 24 flight attendants kept sleep logs, sleep loss was related to the number of night flights, but not to time zone changes (Preston, Ruffell-Smith, & Sutton-Mattocks, 1973).

Recovery duration. The rates of resynchronization of different circadian rhythms lead to transient internal dissociation, in which the normal phase relationships between rhythms are disrupted, resulting in sleep disturbances (Winget et al., 1984). It often takes at least 1 - 2 adaptation nights before sleep onset and efficiency is similar to sleep in a familiar environment (Caldwell, 1997). The rate of rhythm phase shift is most rapid during the first 24 hours and decreases exponentially thereafter (Winget, Bond, Rosenblatt, Hetherington, Higgins, & DeRoshia, 1975). Recovery from 4-day flights has been found to average four days (Harma, Suvanto, & Partinen, 1994).

Seasonal effects. Seasonal effects on circadian rhythm adaptability to transmeridian flight were evaluated in 21 flight attendants during Helsinki-Los Angeles - Seattle-Helsinki flights in both summer and winter. Salivary melatonin and cortisol levels were measured at two-hour intervals for five days before, during, and after the 4-day trip. Circadian rhythm phase shifts in the summer group were significantly greater than the winter group. After the eastward flight, the phase shifts in the summer group were significantly smaller than the winter group. In summer, when there is more environmental light during mornings and evenings, circadian rhythm adaptation was faster after both eastward and westward flights. Late sleeping times increased the exposure to the phase-delaying evening light after the westward flight. After eastward flights, most subjects were still asleep in the morning, and therefore not exposed to the phase-advancing effect of morning light (Harma, Laitinen, Partinen, & Suvanto, 1993).

Individual variability. Characteristics predictive of adaptation rates include circadian factors such as stability and amplitude; personal factors, such as age, motivation and personality; and environmental factors, such as Zeitgeber strength (Winget et al., 1984). Discovery that sleep onset and duration depend upon circadian body temperature phase provides a physiological basis for the performance deterioration observed in response to circadian rhythm desynchronization (Czeisler, Weitzman, Moore-Ede, & Knauer, 1980).

Additional factors

This review has concentrated on those factors affecting fatigue that are most closely associated with the CFRs, i.e., duration and intensity of work, timing of work and rest, and time zone shifts. However, it is important to remember that these are not the only factors impacting off-duty sleep quality and flight-duty performance. One must also consider the impact of aircraft factors such as the aircraft model and configuration, deck arrangements, humidity and air quality; airline factors such as work practices and general culture, as well as individual factors such as age, gender, general health, experience, and the highly variable personal/domestic situation including commuting requirements.

One area that is commonly reported as interacting with, and exacerbating issues of fatigue relates to meals and nutrition. End-of-duty fatigue has been associated with failure to eat dinner and not eating high protein food. There is some evidence that domestic flight attendants have less opportunity to eat during flight legs than international flight attendants, and that flight attendants on regional flights often cannot leave the aircraft between segments, resulting in their missing meals. Reports of occasions when flight attendants arrive at the hotel too

late or leave the hotel too early to eat are not uncommon, even though it has been reported that the consumption of food is known to reduce end-of duty sleepiness, stress, and fatigue among international flight attendants (Galipault, 1980).

As described here, work/rest schedules and knowledge of time zone impacts can provide a level of understanding of fatigue, but multiple other variables also contribute to the fatigue experience.

2. Extrapolation of pilot data

The preponderance of fatigue research relating to flight activities in airline crews has involved predominantly male cockpit crews as reflected in the bibliographies of several reviews of aviation fatigue (Holley, Winget, DeRoshia, Heinold, Edgar, & Kinney, 1981; Holley et al., 2003; Winget et al., 1984). CFRs for pilots and flight attendants are somewhat difficult to compare, since the CFRs applicable to pilots tend to emphasize flight time while flight attendant regulations emphasize duty time. There is a provision in the Handbook Bulletin (HBAT95-16) that provides that flight attendants may be scheduled according to the same rules as pilots. However, in general, CFR-specific-flight-times for pilots tend to be considerably shorter than CFR-specific-duty-times for flight attendants, while the subsequent rest periods are roughly comparable. The population, working environment, and specific activities of flight attendants are considerably different from those of cockpit crews. Pilots generally engage in low physical but moderately demanding navigational, monitoring , and communications activities and periods of intense concentration, high mental workload, close attention to detail, and critical decision making. Cabin crews, in contrast, are physically active during most of the flight time, work in a noisy environment, and operate at a high level of social engagement. However, the effects of fatigue, circadian disruption, and scheduling are sufficiently similar that some findings from pilot studies can be applied to the flight attendant inquiry.

In a major survey of aircrew, cabin crews reported significantly more health problems but no significant differences occurred in sleep and mood variables (Haugli et al., 1994). In a study comparing male flight attendants and cockpit crews during the same 8-time zone transmeridian flight, the only differences found were that pilots reported more awakenings during sleep on the recovery days (Lowden & Åkerstedt, 1999).

A field study of pilot fatigue on short haul flights examined sleep patterns before, during, and after 3- or 4-day commercial short-haul trip patterns. The mean duty time was 10.6 hours with an average of 4 hours 30 minutes flight time, 5.5 flight segments and a total of 12 hours 30 minutes rest periods. On trip nights, subjects took longer to fall asleep, slept less, woke earlier, and reported lighter, poorer sleep quality with more awakenings than on pre-trip nights. During layovers, subjective fatigue and negative affect were higher, and positive affect and activation lower than during pre-trip, flight, or post-trip (Gander, Graeber, Foushee, Lauber, & Connell, 1994). Another field study, relating to long-haul operations (10.3 hours duty period; 24.8 hours layover, two sleep period averages), looked primarily at how pilots organize their sleep during layovers. This study revealed that the circadian system had a greater influence on the timing and duration of first sleeps than second sleeps, while there was a preference for sleeping during the local night. For both first and second sleeps, sleep durations were longer when subjects fell asleep earlier with respect to the minimum of the circadian temperature cycle. The primary conclusion of this study was that the actual time available for sleep during layovers is less than the scheduled rest period due to time zone/circadian rhythm desynchrony. (Gander, Graeber, Connell, & Gregory, 1991).

Using a NASA B747-400 full fidelity flight simulator, a decrease in behavioral alertness was demonstrated during six-hour nighttime flights between Seattle, WA and Honolulu, HI. One of the purposes of this study was to examine the differences in break opportunities in flight as the dependent variable, as well as to assess some common physiological measures. A total of 28 experienced pilots of which 14 served in the experimental condition participated after having been awake between 18 – 20 hours. Statistically significant reductions in behavioral alertness, as seen by lapses in attention and increased response time, were seen over the course of the flights. Participants also reported becoming sleepier across the night. Overall, both subjective and objective measures of sleepiness increased as a function of flight length and circadian factors (Mallis, Neri, Oyung, Colletti, Nguyen, & Dinges, 2001; 2002; Neri, Oyung, Colletti, Mallis, Tam, & Dinges, 2003).

Fatigue has also been identified as a challenge in longer-haul aviation flights. In a field study by Rosekind et al., (1994), physiological alertness and performance data were collected during commercial trans-pacific flights ranging from 6.9 – 9.7 hours in duration. Data revealed that pilots experienced a significant number of microsleep events during the flights. Seventy-percent of the pilots experienced at least one microsleep during the last 90 minutes, which is the landing phase of the flight.

Appendix 2 contains a table listing a number of categories and variables associated with fatigue.

3. Other Surveys

A web-based survey conducted post 9/11, assessed the fatigue of flight attendants working for a major U.S.

airline (Sherry & Philbrick, 2004). This web-based survey revealed pervasive fatigue on a number of dimensions using multiple measures with the authors concluding that the studied cohort was "clearly one of the most fatigued populations we have studied." The data from this study (the average amount of sleep reported was 6.4 hours, an amount known to cause fatigue problems, particularly if continued over a number of days) are significant and revealing, although limited in generalizability since all respondents were employees of a single company.

Another large survey effort (n=4676) conducted by the Employee Assistance Program of a U.S. airline also assessed flight attendant well-being post 9/11. This survey reported primarily on negative mental health symptoms, such as increased anxiety and a state of feeling depressed, but this can have fatigue-related consequences (Corey, Galvin, Cohen, Bekelman, Healy, & Edberg, 2005).

SECTION 3: INCIDENT/ACCIDENT REVIEW

Chapter VI. Sources of Information on Flight Attendant Fatigue

This chapter reviews information gained from an analysis of reports from the ASRS database regarding flight attendants. This chapter also included an examination of the NTSB accident database. The Perilog suite of data mining tools was used to retrieve and organize contextually relevant data from the database. (For more information on Perilog, see McGreevy [2005]). There is a comparatively small ASRS report base from flight attendants and, even using Perilog, only twenty-four reports were identified, with one report coming from the NTSB database.

1. ASRS incident reports

The NASA Aviation Safety Reporting System (ASRS) was searched for reports specific to cabin crew fatigue. This search revealed 17 reports between 1999 and the present, which were based on the following terms: sleep deprived, tired, fatigue, exhausted, long hours, rest deprived, circadian, back side of the clock, schedule problem, duty schedule, flight duty time, and continuous duty overnight (CDO). It is important to keep in mind that flight attendants submit reports to the ASRS voluntarily, and thus the reports do not accurately reflect the actual number of occurrences for each type of event. Therefore, reports are subject to self-reporting bias (i.e., not all cabin crews are equally aware of the ASRS or equally willing to report incidents or events). These reports do not allow an assessment of how often these events occur. The value of these reports lies in the reporter explaining *what* happened and *why* it happened.

The following seventeen reports are offered as most directly related to the CFRs scheduling issue. In general, they reflect difficulty in completing critical tasks, lack of confidence in handling unusual situations, fear for passenger and flight attendant safety, and general symptoms of fatigue. These reports are referred to by their ASRS Access Numbers and have been condensed to draw attention to the relevant information:

ACN 614712 – Flight attendant advises that routine assignment of maximum duty days coupled with minimum rest periods results in unacceptable deterioration in performance of safety related duties. Flight attendant did not feel safe with layover minimum guidelines of eight hours coupled with 10-14 hours on duty. Further, she reported previously falling asleep on her jump seat during taxi in and out of gates. "I forget the easiest tasks, including arming my doors for takeoff and giving safety briefings to passengers on an exit row." Flight attendant reported being too fatigued to look for suspicious behavior as required for security.

ACN 605017 – A diversion due to a medical emergency resulted in the flight attendants being short on rest. A number of passenger situations arose causing the flight to be delayed. There was an additional diversion for an unscheduled landing and a delay deboarding at the final destination. The flight attendant called crew tracking to report their illegality and was advised to call from the hotel for a new sign-in time. Once at the hotel, the flight attendant called crew tracking and was given a new sign in time. The flight attendant reported being too fatigued to realize that they were not given legal rest time. Flight attendant reported that they should have been given a 10-hour minimum rest break after a 14 hours and 30 minutes day (flight attendant actually was on duty for 16 hours). Instead, they were given eight hours and 27 minutes on paper, which the flight attendant estimated to consist of five hours of sleep. The flight attendant did not realize she was still illegal until the next day during a 12-hour flight. The flight attendant ended up on duty for 28 hours during a 36-hour trip. This was a night flight.

ACN 601176 – Flight attendant reported that a layover was cut too short due to a delay leaving the previous day. During the next duty period, the flight attendant did not feel confident dealing with a passenger situation after not having obtained enough sleep.

ACN 598805 – A departure delay and a diversion to an entirely different airport due to a mechanical problem resulted in a late arrival at the destination. These delays resulted in minimum rest along with the inability to acquire food for the crew, which was cited by the flight attendant as a safety hazard. Reported duty time was 14 hours and 59 minutes. By the time the flight attendant arrived at the hotel room, seven hours remained before

the return flight. The flight attendant reported that the only food provided was cake at the hotel. One flight attendant felt the effects of the situation and was not able to return to duty the next day. "We were exhausted due to the lack of layover time to sleep." The reporting flight attendant felt safety was compromised.

ACN 592062 – The flight was diverted to another airport as a precaution. The flight attendants were required to stay onboard with the passengers for two hours and 14 minutes before preparing for the second departure. The flight attendant reported calling crew tracking to question legalities of return flight home. "Tracking stated that as long as we weren't 'scheduled or rescheduled' to be on duty over 14 hours, that we were legal." Reported duty time was 15 hours and 38 minutes on a night flight. The flight attendant complained of fatigue and no rest break opportunity.

ACN 590450 – The flight attendant reported obtaining only seven hours and 30 minutes of sleep on each overnight followed by duty days exceeding 13 hours. Flight attendant reports needing more "behind the door time."

ACN 522844 – The flight attendant reported loss of control of passengers on board a diverted airliner sitting on the ramp. During the flight, flight attendants encountered passenger illness (requiring medical attention), passenger misconduct (theft of airplane flashlight), weather, and food service problems (low on supplies). Crews were on duty for 17 hours and 30 minutes. This was a night flight.

ACN 510411 – The flight attendant reported flying nine days straight without a calendar day off but was legal by 6 minutes. Flight attendant complained of being intimidated to fly. Though legal, she cited extreme fatigue as being detrimental to her ability to perform her duties on aircraft.

ACN 459500 – A passenger had a seizure, which led to a divert landing so the passenger could be removed. While refueling, there was a fuel spill, which caused passengers and flight attendants to get sick from the fumes. The flight attendants received minimum rest after the incident. "Crew only had eight hours rest and had to work the next day. I think rest should have been longer after such a stressful situation."

ACN 448619 – A fuel leak on the flight caused the plane to return to the airport where the flight was cancelled. The pilots went illegal, but the cabin crew were not. Flight attendants reported bare minimum rest, which caused fatigue.

ACN 441257 – The auxiliary door light came on during flight, so the plane returned to the airport for maintenance. The flight attendant reported that they had to land heavy. Flight attendants realized they were illegal after they were airborne. "My feeling is they had enough to do without also having to establish their legality. I was not happy to hear that dispatch asked the captain to ignore the situation and continue on."

ACN 110833 – The cabin crew were overworked and fatigued as a consequence of bad weather in Houston, which resulted in a 45-min delay, followed by a diversion to Austin, a hold on the ground for 1 hr 25 min, an aircraft change and return to Houston, and an additional diversion to Dallas. In Dallas, the captain requested the cabin crew be replaced due to mental and physical fatigue. The cabin crew had been on duty for 14 hours. The flight attendant called scheduling and told them that due to exhaustion and fatigue, they could not function in any emergency and must be replaced. The cabin crew were replaced but then suspended for seven days for making an unauthorized decision for the safety of the passengers and crew.

ACN 330380 – The cabin crew finished with 10 hrs 12 minutes flight time and 18 hrs 45 minutes on duty due to an abandoned approach to Atlanta due to wind shear, diversion to Chattanooga, refueling on to Atlanta, another diversion to Rockford, Il, with final arrival at Chicago, where the cabin crew arrived exhausted. They were then sent to the hotel for a short night and took the flight out the next morning.

ACN 387700 – A flight delay resulted in insufficient cabin crew rest since their rest period was less than nine hours.

ACN 400339 – A takeoff delay due to an engine problem resulted in the flight attendants flying illegally since the delay resulted in excess duty hours.

ACN 476689 – The cabin crew ready for deadheading had to replace in the last minute a crew that already went illegal. Two of the latter crew were to deadhead but yet were reassigned to work as part of the currently assigned crew. Reporting flight attendant was made the purser, even though she was not qualified. Situation created was totally chaotic resulting in door one not being manned during take-off, nor was a crew briefing held.

ACN 544180 – After a lengthy sit on the taxiway at Dallas-Fort Worth, the flight attendants went illegal as per the CFR's regarding length of duty day, and additionally had to cope with an intoxicated passenger.

2. NTSB accident report

In one accident flight attendant fatigue has been identified as a contributing factor (NTSB ID No. CHI95IA215). The American Eagle Flight 4127 operated by Simmons Airlines (ATR-72 aircraft) was a regularly scheduled flight from Chicago's O'Hare International airport to South Bend, Indiana. Shortly after takeoff from O'Hare International Airport, the cabin entry

door separated from the airplane. Flight 4127 returned to O'Hare International Airport and landed. The No. 1 flight attendant sustained minor injuries. No other occupants were injured. The cause of the incident was the failure of the No. 1 flight attendant to close the aft entry door. She stated that she did not have any trouble closing the boarding door. Even though she could hear air coming through the door, she stated that she did not think of calling the cockpit when she heard the sound of the door leak before it separated, because the aircraft was under sterile cockpit conditions. When queried as to under what conditions she would call the cockpit when sterile, she responded that she would in case of fire or a problem passenger. The flight attendant had been on duty about 14 hours and 30 minutes on the day of the incident with only five hours of sleep the previous night due to her flight schedule.

SECTION 4: CREW SCHEDULING ANALYSIS

Chapter VII. Examples of Cabin Crew Schedules

1. Examples of various airline schedule practices

In an effort to investigate to what extent the flight attendant fatigue issue might be related to scheduling practices, four carriers' application of the regulations for hours of service were randomly selected as examples. It is not known from such a small sampling if these are representative and consistent across all carriers, however, the literature suggests that schedules are highly variable. It should be remembered that the CFRs are limits from which each carrier derives their particular scheduling practices, respective of bargaining unit agreements.

With this in mind, the following are examples of scheduling practices for hours of service for two domestic and two regional carriers as retrieved from their respective websites. This information is provided for a general understanding of flight attendant duty and rest limitations based on the current CFRs as understood by the airlines and as agreed to through collective bargaining.

Example 1: Airline A (Domestic): **Hours of Service**

The overall schedule, according to Airline A requires that flight attendants flying domestically have a monthly schedule maximum of 80 hours. At the discretion of the flight attendant, the workload may be increased up to 85 hours for make-up assignments. Duty commences no less than one hour (30 minutes if deadheading) before the scheduled departure and ends no less than 15 minutes after arrival. The scheduled on-duty maximum per duty period is 12 hours and 30 minutes. From the report time to block-in, the actual on-duty maximum is 14 hours.

a) **30-hours in 7 days limitation:** A flight attendant may not be scheduled for more than 30 hours of actual flight time in any seven consecutive days. This limitation may be exceeded by the flight attendant, provided that the flight attendant was not *scheduled* to do so.

b) **24-hours off in 7 days limitation (24-in-7):** A flight attendant must be relieved from duty for at least 24 hours (off-duty) in any seven consecutive days. This may occur at home base or as part of a layover. The 24-in-7 is a federal regulation and may not be waived by the flight attendant or by management.

c) **8-hours in 24-hours limitation:** A flight attendant may not be scheduled for duty aloft for more than eight hours during any single duty period on trip sequences consisting of two or more duty periods, or may not be scheduled for more than eight hours and 59 minutes on a trip sequence of a single duty period (i.e., turnarounds). Duty aloft does not include deadhead time. A flight attendant may be scheduled for more than eight hours as long as rest is scheduled as specified by the layover rest period regulations.

d) **Layover Rest:** A duty period shall run continuously unless broken by a scheduled rest period. For scheduled duty of less than nine hours during any 24-hour period, the scheduled rest shall be a minimum of 10 hours. For duty periods of nine hours or more, the scheduled rest shall be a minimum of 11 hours.

e) **Reduced Rest:** Scheduled rest periods may be reduced provided that compensatory rest is scheduled after the on-duty period following the reduced rest period and commences no later than 24 hours from the beginning of the reduced rest period (Table 2). This is consistent with 14 CFRs §121.467 and §135.273.

Table 2: *Scheduled Rest Reduction and Compensatory Rest*

Scheduled Duty Aloft during any 24-hour period	Reduced Rest*	Compensatory Rest
< 8 hours	8 hours	10 hours
> 8 hours, but < 9 hours	8 hours	11 hours
≥ 9 hours	9 hours	12 hours

*The 1 hour or 30 min report time and 15 min debrief time are considered part of all on-duty periods.

f) **Behind the Door Rest (time available for rest in a hotel or rest facility):** Reduced rest of eight or nine hours does not include travel time required between the airport and layover facility. Travel time will not reduce the eight or nine hours behind the door rest. If transportation reduces this amount of time, the flight attendant must contact Crew Tracking to advise them of the rest required to comply with this "behind the door" provision.

g) **Home Base Rest:** When at home base, the flight attendant shall receive an off-duty period of no less than 11 scheduled hours.

Example 2: Airline B (Domestic): **Hours of Service**

According to Airline B the schedule maximum is 92 hours for one month, 184 hours for two months and 261 hours for the full quarter. A flight attendant may elect to increase the scheduled duty time to 97 hours for the first month, 194 hours for the first two months and 267 hours for the full quarter. Ten calendar days shall be scheduled off each month at home base; however, a flight attendant may voluntarily reduce the number of calendar days off. Duty period commences between 45 minutes to one hour and 15 minutes (30 minutes for deadheading) prior to flight time depending on the aircraft and ends no less than 15 minutes after the block-in arrival of the flight away from home base or 30 minutes after the block-in arrival of the flight at home base. A flight attendant may be scheduled for duty up to 13 hours with an actual period of 14 hours and 30 minutes.

a) **30-hours in 7 days limitation:** A flight attendant may not be scheduled for more than 30 hours of actual flight time in any seven consecutive days. This limitation may be exceeded by the flight attendant, provided that the flight attendant was not *scheduled* to do so.

b) **24-hours in 7 days limitation (24-in-7):** A flight attendant must be relieved from duty for at least 24 hours in any seven consecutive days. This may occur at home base or as part of a layover. The 24-in-7 is a provision of the CFR and may not be waived by the flight attendant or by management.

c) **1-day in 7 days limitation:** A flight attendant must be scheduled to have at least one day off every seven days. This may be waived by the flight attendant and is considered a distinct and separate limitation from the 24-in-7 limitation.

d) **8-hours in 24-hours limitation:** A flight attendant may not be scheduled for duty aloft for more than eight hours during any single duty period without the prescribed rest. On trip sequences consisting of two segments during one duty period, a flight attendant may not be scheduled for more than eight hours and 30 minutes. Duty aloft does not include deadhead time. A flight attendant may fly more than eight hours in a 24-hour period provided that the flight attendant receives two hours off duty for every one hour of actual flight time in the preceeding duty period before going over the eight hours and the flight attendant must receive at least 16 hours off from duty at the next scheduled rest after exceeding the eight hours.

e) **Layover Rest:** A flight attendant shall receive nine hours free from duty where lodging is provided close to an airport (within 15 minutes), or 11 hours where lodging is provided more than 15 minutes away from the airport.

f) **Home Base Rest:** When at home base, the flight attendant shall receive an off-duty period of no less than 10 scheduled hours.

Example 3: Airline C (Regional) **Hours of Service**

The overall schedule for Airline C states that a flight attendant may not be scheduled to fly more than 118.2 trips for pay or 90 flights, whichever is less. The flight attendant may elect to exceed the monthly maximum. This monthly maximum is not calculated by number of duty hours per month. Duty commences one hour prior to scheduled departure at home base (45 minutes away) and ends 30 minutes after block-in. Deadheading is considered part of duty and subject to duty limitations. The daily maximum a flight attendant may be scheduled is 10 hours and 30 minutes. The actual flight maximum may be extended up to 12 hours and 30 minutes. However, if a flight attendant flies over the 12 hours and 30 minutes maximum, a scheduled rest period of equal to double the time spent on duty on the day the duty exceeded the maximum must be given immediately following the return to home base.

a) **Trip Number limitation:** A flight attendant may not be scheduled for more than eight flights in any 24-hour period unless broken by legal rest and may not be *scheduled* for more than 28 flights in any seven consecutive days. However, a flight attendant may elect to fly over the limit.

b) **48-hours in 7 days limitation:** A flight attendant must have no less than 48 continuous hours off duty within any seven consecutive days.

c) **Scheduled Rest:** A duty period runs continuously unless broken by overnight rest scheduled for 11 hours block-to-block. This may be reduced to eight hours and 45 minutes when no more than two flights are scheduled following the rest period. The maximum duty time following the reduced rest is four hours. If a flight attendant on a multi-day sequence receives less than 10 hours rest block-to-block, the flight attendant may be replaced and paid for the remainder of the duty sequence if the sequence terminates at home base. The flight attendant may elect to remain on the sequences for additional pay until the flight attendant receives crew rest. A minimum

of 13 hours rest block-to-block at the home domicile is scheduled between each trip sequence. The flight attendant may elect to reduce this rest period.

Example 4: Airline D (Regional) **Hours of Service**

According to Airline D a flight attendant shall not be scheduled for more than 90 hours per month. Duty commences one hour prior to departure at home base (45 minutes away from home base) and ends 15 minutes after block-in. A flight attendant may be scheduled for up to 13 hours off-duty with the actual duty time lasting approximately 14 hours and 30 minutes.

a) **Trip Number limitation:** No trip number limitation was identified. However, based on a scheduled 13-hour duty day, seven landings will occur.

b) **1-day in 7 days limitation:** A flight attendant shall receive one calendar day at home base off duty during every seven calendar days. The flight attendant may elect to take the day at a layover city and/or 24 hours free from duty in lieu of the calendar day.

c) **Scheduled Rest:** At home base, minimum rest is scheduled for 11 hours, but is waiveable to 10 hours by the flight attendant. On layovers, scheduled rest is nine hours and 15 minutes, but may be reduced to eight hours. The rest requirements and duty time limitations for flight attendants shall in no event be less than those provided by the CFRs.

The four examples provided contain considerable overlap in scheduling regulations with the noteworthy differences presented in the following table (Table 3).

2. Samples of actual cabin crew airlines schedules

In order to assess how closely flight attendant schedules reflect the CFRs, it was necessary to examine recent, actual flight attendant schedules. A sample of 36 flight attendant schedules with all identifying information removed to maintain confidentiality was initially obtained. This sample provided an opportunity to examine actual flight attendant schedules. However, it should be noted that all 36 schedules come from a single major U.S.

Table 3: *Comparison of Scheduling Examples Between Regional and Domestic Airlines*

	Domestic		Regional	
	Airline A	Airline B	Airline C	Airline D
Monthly Maximum	80 hr	92 hr	90 flights	90 hr
Monthly Maximum Extended	85 hr	97 hr		
Duty Maximum Scheduled	12 hr 30 min	13 hr	10 hr 30 min	13 hr
Duty Maximum Actual	14 hr	14 hr 30 min	12 hr 30 min	14 hr 30 min
Trip Limitation			8 trips in 24 hr; 28 trips in 7 days	
30 hr in 7 days Limitation	√	√		
24 hr in 7 days Limitation	√	√		
	Domestic		Regional	
	Airline A	Airline B	Airline C	Airline D
1 day in 7 days Limitation		√		√
48 hr in 7 days Limitation			√	
8 hr in 7 days Limitation	√	√		

airline; it is assumed that there is considerable diversity in scheduling practices among airlines. The extent to which these examples reflect the many diverse schedules projected across the aviation industry is unknown at the time of this report.

Each schedule, which pertained to one or more flight attendants at a time, consisted of two- or three-duty-day routes with multiple flight legs per day and an off-duty layover period between each duty day. The flight attendants started from their respective home base location on the first duty day and returned to their home base on the last duty day. Certain scheduled routes required the layover to occur in a site located in a different time zone from the home base. Though each flight leg, on-duty duration, and off-duty/layover duration was scheduled in advance, many factors such as flight delays and transportation to and from the airport caused the *actual* duty times to vary; therefore, both scheduled and actual times are provided.

Further, the flight attendants were divided into two groups, according to whether two or three duty days were reported; this distinction was necessary because the flight attendants with three-day schedules did not return to their home base until the end of the third duty day. The schedules provided were examined based on number of time zone crossings (i.e., location of layover in relation to both the home base and to the previous night's layover location), number of flight legs flown per day, actual on- and off-duty length of time, and scheduled on- and off-duty length of time. Descriptive statistics were calculated and then analyzed to determine whether the schedules reflected the current CFRs as stated in Chapter III of this report.

Briefly, none of the flight attendants included in this sample was scheduled for 14 hours or more of duty; however, some reports of *actual* duty time exceeded 14 hours. At this point, it was not possible to determine if rest periods were scheduled in accordance with the CFRs because the given schedules reported neither the scheduled nor the actual off-duty time following the last duty day. Due to this omission, only the layover rest periods could be evaluated in terms of amount of scheduled rest time, amount of actual rest time, and time zone of rest location in relation to home base (for two-duty-day group) as well as in relation to previous layover location (for three-duty-day group). For the given sample, all layovers were within two time zones (± two hours) compared to both home base and previous night's layover. The results of on- and off-duty hours are presented separately in relation to the two groups of flight attendants.

Flight Attendants scheduled for two-duty days.

Twenty-five of the 36 flight attendant schedules analyzed consisted of only two duty days with one layover. Of those 25, 12 flight attendants were *scheduled* for 12 or more hours of on-duty time on the first duty day. When compared to *actual* on-duty time, nine of the 12 flight attendants had worked 12 or more hours, and the remaining three flight attendants worked 14 or more hours. Off-duty time for all 25 flight attendants ranged from eight hours to nine hours six minutes, with seven flight attendants *only* receiving a total of eight hours off-duty. On Day 2 of the scheduled routes, 12 flight attendants were scheduled to work 12 or more hours. When compared to *scheduled* duty time, nine flight attendants worked 12 or more hours, and three flight attendants worked 14 hours or more with possible reduced rest.

Flight Attendants scheduled for three-duty days.

The remaining 11 of the total 36 flight attendant schedules consisted of three duty days with two layovers. *Actual* on-duty time for Day 1 ranged from four hours (only one flight leg flown) to 12 hours 36 minutes, with one flight attendant scheduled for and actually working 12 or more hours. Scheduled off-duty time ranged from eight hours one minute to 15 hours 32 minutes, while actual off-duty time ranged from eight hours four minutes to 15 hours 48 minutes. On Day 2, scheduled on-duty time ranged from eight hours 24 minutes to 12 hours 52 minutes. Actual on-duty time ranged from eight hours 54 minutes to 14 hours 17 minutes, with only three flight attendants working less than 12-hour days.

Ten of the 11 flight attendants with three duty-days were *scheduled* for 10 hours 35 minutes or less off-duty time (the remaining flight attendant was scheduled for 35 hours 13 minutes off-duty; notice that the mean and large standard deviation in Table 4 reflect the significant influence of this lengthy scheduled off-duty time for the 11th flight attendant). However, the *actual* off-duty for the same 10 flight attendants ranged from eight hours to eight hours 56 minutes, which is a difference of up to one hour 39 minutes from s*cheduled* off-duty time (Once again, the mean and large standard deviation in Table 5 reflect the significant influence of the 11th flight attendant's off-duty time). On the third duty day, three flight attendants were scheduled for 12 or more hours on duty. Two flight attendants actually worked 12 hours or more, but none worked more than 12 hours 30 minutes.

The means and standard deviations for both *scheduled* and *actual* on- and off-duty times for all 36 flight attendants are presented in Tables 4 and 5 for comparison purposes only (please note that these data represent a very small sample of schedules within a single airline and do not reflect a scientific trend across the industry).

Table 4: *Means and Standard Deviations (S.D.) for* ***Scheduled*** *On- and Off-Duty Time Lengths*

		Day 1 on-duty	Day 1 off-duty	Day 2 on-duty	Day 2 off-duty	Day 3 on-duty	Day 3 off-duty
*Two-duty-days**	Mean	9:46	9:34	11:27	n.a.	n.a.	n.a.
	S.D.	2:32	1:18	1:25	n.a.	n.a.	n.a.
Three-duty-days**	Mean	7:27	10:45	11:48	11:30	9:13	n.a.
	S.D.	3:19	7:31	1:24	7:53	2:20	n.a.

*n = 25 **n = 11

Table 5: *Means and Standard Deviations (S.D.) for* ***Actual*** *On- and Off-Duty Time Lengths*

		Day 1 on-duty	Day 1 off-duty	Day 2 on-duty	Day 2 off-duty	Day 3 on-duty	Day 3 off-duty
*Two-duty-days**	Mean	10:45	8:25	12:04	n.a.	n.a.	n.a.
	S.D.	2:54	0:31	1:33	n.a.	n.a.	n.a.
Three-duty-days**	Mean	7:44	10:48	12:21	11:09	9:33	n.a.
	S.D.	3:20	2:05	1:38	8:27	2:30	n.a.

*n = 25 **n = 11

Note: *The* ***actual*** *mean time on-duty (Table 5) exceeded the* ***scheduled*** *time (Table 4) in all cases, with one exception. The* ***actual*** *mean time off-duty was generally less than the scheduled off-duty time where data was available.*

Factors affecting rest during layovers.

On nine of the provided 36 schedules, flight attendants wrote subjective comments with the following complaints:

Lack of food: Delayed flights, short turnaround times between flight legs, and reduced rest periods do not allow enough time for meal breaks. One flight attendant described these schedules as "bad planning" while another dubbed them "inhumane".

Lack of adequate sleep: With a shortened layover following a 12-hour day, or even placed in between two 12-hour or longer duty days, flight attendants were not able to acquire a full eight hours of sleep. According to the written comments, having to manage a full work day after only six hours of actual sleep often leads to exhaustion and fatigue on the job.

Late bedtimes and early wake-up times: Getting in to the layover hotel at a late hour, sometimes due to transportation delays, and having to get up early the next day for duty also had a negative impact on flight attendants' ability to obtain rest. For example, one flight attendant complained that the pick-up van came late, thus causing the flight attendant to arrive at the hotel at 00:10 after ending a 12-hour workday at 22:50. The flight attendant then woke up early in order to be picked up at 06:40 and to start duty on Day 2 at 07:08. Another flight attendant, on a three-duty-day schedule, arrived at the hotel at 22:33 following a 13 hour 25 minute duty day and woke up at 05:15 to begin work at 05:50. This flight attendant was only able to obtain five hours of sleep.

Such comments, although anecdotal, indicate that scheduling factors that neglect adequate time for meal breaks, long duty days, and an overall decreased rest time may affect flight attendants' abilities while on duty. Anecdotal reports also allow for a general comparison between "good" and "bad" flight schedules. The latter depend on the number of passengers to be served (on average 50 passengers per flight attendant), having sufficient breaks in between flights (anywhere between 15 - 53 minutes between flights) and a long enough layover period (e.g., 10 hours).

In summary, of the schedules evaluated in this sample, on-duty and off-duty/layover times were *scheduled* to be compliant with the CFRs, but the *actual* times of some of those schedules extended beyond these limitations. When comparing scheduled and actual on-duty times, the average actual on-duty times were longer in duration than scheduled times. These differences in increased duty time resulted in decreased off-duty time, which in turn may have negatively affected the amount of sleep flight attendants were able to obtain during layovers. According to the sample of schedules provided, no decreased off-duty time resulted in layover periods of less than eight hours. However, eight hours of off-duty time *would not* allow for adequate sleep time due to the time associated with travel to/from the airport, personal hygiene and nourishment, and poor sleep quality due to time-of-day. Efforts are really needed to gain a better understanding of the percentage of schedules that result in the potential for sleep loss and performance decrements.

3. Additional Schedules Analysis

The initial analysis included 36 flight attendant schedules, in which the number of duty days per schedule, number of time zone crossings, and length of layover and duty times were analyzed and discussed. Additional flight attendant schedules became available following the first analysis and were obtained from a variety of carriers including regional, domestic, and low-cost operations. The regional carriers were further divided into those that followed flight attendant CFRs and those where the flight attendants followed the same fatigue-related rules as the pilots. Many of these additional schedules could not be included in further analyses because they either were illegible, reflected a single duty day, or represented international flights. We were however, able to extract flight times, duty times, layover times, and locations for trips of two or more days for 122 individually flown schedules. These schedules are shown in Appendix 3.

Important information can be gained from these examples even though they do not represent a scientifically selected sample. They are simply schedules that were provided because of their availability. This information is summarized below in Table 6.

This limited sample suggests that the regional and low-cost airlines tend to fly somewhat shorter flights than the domestics carriers and, based on this sample, may have somewhat longer layovers than the domestic operations. However, a more rigorous analysis with more schedules should be made to address the differential nature of industry operations.

4. Description of unknowns regarding schedules

Though the flight attendant schedules provided by the domestic carriers included valuable information, other details are needed to complete a full analysis. As mentioned previously, both scheduled and actual off-duty times after the last duty day reported for each schedule were not provided. It is not possible to determine if enough off-duty time is provided in accordance with the CFRs and layover rest periods cannot be compared to subsequent rest periods after a trip. Also, without knowing the amount of rest following a trip, one cannot determine if sufficient recovery sleep can be obtained before the next duty day commences. Also unknown is whether the listed times are in local time or Greenwich Mean Time (GMT), and at what time of year these particular schedules occurred (dates are listed on some schedules, but not all). For example, if the schedules took place after local time was changed to Daylight Savings Time, the combined impact can further affect flight attendant schedules.

Chapter VIII. Fatigue Models

An objective of this activity was to assess a sample of schedules through the application of existing predictive fatigue models (See Appendix 4 for overview of several models). Three models were selected for this experiment and included: the Two-process model (Achermann, 2004), the Astronaut Scheduling Assistant model (ASA; Van Dongen, 2004), and the Fatigue Avoidance Scheduling Tool model (FAST™; Hursh et al., 2004). These models are described in Appendix 5.

Analysis of flight attendant schedules through different models was not to directly compare one model against another, but to demonstrate if the models would produce consistent predictions, regardless of the slightly different input settings required of each respective model. Also, by utilizing a sample of models, rather than just selecting one might provide evidence that some of the schedules currently in practice produce negative outcomes (in terms of predicted sleepiness or loss of effectiveness).

Examining the results (seen in Appendix 6), considerable promise was demonstrated in that the predictions of fatigue were consistent with variations found in flight attendant schedules. Although we did not have actual flight attendant performance data to compare with the predicted outcomes of the different models, these examples demonstrated the potential utility of predictive models and recommend further development and validation.

SECTION 5: FINDINGS

This report was focused on several issues related to flight attendant fatigue. Following a review of the FARs we briefly discussed flight attendant responsibilities and how they have changed following 9/11. This was followed by a review of the literature on flight attendant fatigue that included relevant information from fatigue-related studies of flight crew. Information was then provided regarding incident data from the ASRS and one accident concerning flight attendant fatigue from the NTSB database. The final section of the report was focused on information gained from the examination of flight attendant work schedules, based on a sample of convenience initially from a single carrier (36 schedules) and subsequently from a small group of regional, domestic, and a low-cost carrier. Within this section we applied three fatigue models to three of the schedules. In this section we will attempt to combine and distill the understanding gained from these several sources to determine what we have learned that can inform our examination of regulations and practices as related to the scheduling of flight attendants.

Table 6. *Flight duration and layover time for a sample of schedules by carrier operation*

A. Domestic, n=63

Average (hr:min)	Day 1	Day 2	Day 3	Day 4
flight duration (range)	6:02 (1:20-10:26)	7:30 (4:42-10:44)	6:48* (1:47-12:10)	4:07** (1:49-8:08)
layover time (range)	9:38 (8:00-17:32)	13:16* (8:00-35:13)	11:29** (8:00-16:19)	

*n=24, **n=4

B. Low-cost, n=36

Average (hr:min)	Day 1	Day 2	Day 3	Day 4
flight duration (range)	6:04 (3:17-9:57)	5:38 (3:27-8:35)	5:11* (1:31-9:53)	7:32** (5:58-8:21)
layover time (range)	14:42 (10:15-18:57)	15:11* (10:00-20:08)	14:01** (10:12-17:00)	

*n=33, **n=4

C. Regional, n=13

Average (hr:min)	Day 1	Day 2	Day 3	Day 4
flight duration (range)	5:50 (2:50-7:50)	5:56 (3:26-7:41)	5:55* (4:20-7:20)	5:43** (4:02-7:13)
layover time (range)	12:54 (9:56-20:00)	15:08* (11:10-21:53)	12:31** (10:41-13:54)	

*n=7, **n=3

D. Regional, pilot rules; n=10

Average (hr:min)	Day 1	Day 2	Day 3	Day 4
flight duration (range)	6:33 (3:26-7:47)	5:32 (2:29-7:53)	5:53* (4:04-7:57)	5:04** (3:53-6:53)
layover time (range)	11:12 (8:45-20:08)	12:40* (8:58-19:23)	10:45** (8:48-13:24)	

*n=8, **n=5

Chapter IX. General Findings

There are two main causes of fatigue: sleep loss and desynchronization of circadian rhythms with schedule activity and sleep (Borbély, 1982). These components interact dynamically to regulate changes in alertness and performance. Sleep loss accumulates into sleep debt leading to increased sleepiness (Roehrs et al., 2000). Further, circadian rhythms contribute to fatigue when there is a conflict, or lack of synchrony, between environmental cues and one's biological clock. Jet lag and shift work are such causes of circadian lack of synchrony, both of which are found to occur with operational flight attendant scheduling.

1. Impact on safety

In general, flight attendants are the in-flight primary responders who must be vigilant to the possibility of security and other threats, perform CPR, fight a possible fire, and evacuate the aircraft in the event of an emergency landing or accident. The incidents found in the ASRS database reflect a perception among the flight attendants reporting them, that fatigue and performance are safety issues. One NTSB accident report indicated that flight attendant fatigue contributed to that accident. The literature reviewed also contains information relating fatigue to safety concerns and suggests the intervening states by which fatigue can lead to safety problems.

There is a general absence of information for both flight attendants and flight crew regarding the fatigue-related changes in performance associated with the frequent arrivals and departures occurring for many regional carriers, though a recent NTSB accident summary report indicated that these factors "…contributed to the pilots' degraded performance and decision making." (http://ntsb.gov/publictn/2006/AAR0601.htm) Additional information is needed to adequately understand the effects that multiple takeoffs and landings have on flight crew performance and their safety-related duties in response to the NTSB safety recommendation (A-06-10).

Sleep loss effects

The sleep losses documented in this report raise operational performance and safety concerns by reference to other studies. It has been shown in various ground-based studies that such levels of sleep deprivation affect neurobehavioral functioning that result in increased reaction times, memory difficulties, cognitive slowing, and increased lapses of attention (Ferrera & DeGennaro, 2001). The time period immediately following awakening from sleep (sleep inertia) can also result in performance task impairment and/or disorientation. This phenomenon lasts for at least 5 minutes even in non-sleep deprived subjects (Dinges, Orne, Evans, & Orne, 1981). Frequent forgetfulness, difficulty making up one's mind, or doing things rashly, were reported by 30-56% of flight attendants referenced in the early survey studies conducted by Alter and Mohler (1980), and Galipault (1980), as well as in the more recent survey of 674 flight attendants (Morley-Kirk & Griffiths, 2003). Even the early studies mention flight attendants feeling unable to deal with an emergency associated with very high end-of-duty fatigue and sleepiness, or rated themselves as only "fair" or even as "poor" in their ability to respond to emergencies at the end of a 15 hour flight. Symptoms reported included difficulty in decision making (11%) and in recall (24%) (Suvanto & Illmarinen, 1987a).

Circadian effects

Memory lapses are clearly related to disturbances of circadian rhythms and are associated with time zone changes and night work. Such lapses are manifested in performance inefficiency (Suvanto & Ilmarinen, 1987a). Symptoms of jet-lag in flight attendants flying transmeridian routes include disorientation and vagueness, in which respondents mentioned incidents such as having to return to their hotel room three times to check if they had locked the door. Disorientation was reported by 53% of 228 flight attendants surveyed (Criglington, 1998).

As previously outlined, performance problems associated with fatigue include: microsleeps (brief intrusions of EEG indicators of sleep greater than 5 sec), lapses in attention, slowed reaction time, increase in errors, doing things in a slipshod manner, short-term memory impairment, lack of situational awareness, and impaired decision making. The non-routine situation presents the greatest challenge to the effective performance required of flight attendants. It is here that the effects of fatigue and circadian disruption would be expected to have the most serious impact on safety.

2. Impact on well-being

There are no known studies that deal with the specific effect of fatigue on flight attendants' quality of life. Several studies do relate flight experience generally with cognitive effects and conclude that these effects are associated with fatigue/circadian factors. These studies suggest a higher-than-expected rate of neuropathology in flight attendants (Dalitsch, Fishback, Parmet, Bono, & Mayo, 2005), impaired memory performance and slower reaction time for international flight attendant crews when compared with ground crews (Cho, Ennaceur, Cole, & Suh, 2000) and the possibility of chronic neurological and performance deterioration following chronic circadian disruption that is unrelieved by adequate recovery periods (Cho, 2001). As mentioned previously, Cameron (1969)

had 98 flight attendants participate in a questionnaire study before, during and after their flying careers, which resulted in reports of severe difficulty concentrating to increase from 0.0% prior to their flight attendants' career to 13.5% during their flight attendant career, and then a decrease to 3.2% after their flight attendants' career. It is noteworthy to point out that this is a survey conducted in 1969.

It seems clear that impacts related to performance and safety would have corollary impacts on well-being. One of the most commonly reported effects of fatigue is degradation of mood and motivation. Research has demonstrated that with increased sleepiness, there is an increase in reports of total mood disturbance (Dinges et al., 1997). Testiness and breakdown of social interactions are commonly reported among the fatigued. More specifically, sleepy people often report an increase in confusion, tension, anger and depression as well as a decrease in vigor. A recently released study of the impact of 9/11 on flight attendants' well-being (Corey et al., 2005) provides information on the stressors introduced by the attack and the mechanisms employed by flight attendants to cope with these new conditions.

Chapter X. Conclusions

The need for sleep is essentially a physiological response, which although varying among individuals, is universal. Offsetting fatigue requires sleep, rest and time to recover. The need for recovery is further influenced by the circadian cycle, which in turn is influenced by the time of day, time zones crossed, and lighting.

The off-duty or rest period for flight attendants includes time to wind down or fall asleep, actual sleep, and time to perform related tasks such as clear customs, get to and check into the hotel, procure meals, groom, call home, and the like. The time required for most of these tasks and the time devoted to fall asleep is unavoidable, with the result that reductions in off-duty time must be absorbed by the time that should be devoted to sleep.

A review of the evaluation materials available for this report, including a literature review on fatigue and circadian disruption, a sampling of schedules, incident/accident reports, and comments provided by a number of flight attendants, has suggested that some segments of this workforce were experiencing issues consistent with fatigue and tiredness. As such, flight attendant fatigue appears to be a salient issue warranting further evaluation. The Committee on Appropriations (House Rpt. 108-671) suggested that the practice of airlines to schedule closer to the CFR minima on a more regular basis, and very short periods post-flight before the beginning of the rest period may be contributing to this effect. However, the limited nature of the study did not allow us to determine the extent to which scheduling practices either within a single carrier or across carriers were problematic. An additional factor is the difference between the *scheduled* work/rest periods and the *actual* work/rest periods as they play out in field operations. Aircraft-related and weather delays as well as other unforeseen operational events contribute to extending a duty period beyond what was originally scheduled.

The relevant CFRs have been in place since 1994, but from flight attendant reports and some bargaining unit concessions regarding staffing and scheduling has suggested that some airlines have recently been operating near the CFR minima. Just how widespread these near-CFR practices are cannot be determined at this time. Based on the incident reports, flight attendant comments, and the outcomes from the sampling of actual duty and rest times, it appears that the opportunities for adequate rest for flight attendants need to be further evaluated.

CFRs provide end points or not-to-exceed levels of regulation. But CFRs do not, and perhaps cannot, capture the multiple variables that impact fatigue and the individual's ability to tolerate fatigue. Taken from the standpoint of just the pre-determined dimensions of the flight itself, the CFRs do not distinguish among the number of segments flown, daytime versus nighttime flights, flights that are uni-meridianal vs. those that are transmeridianal, regional versus domestic flights.

To truly address the fatigue issue, regulations must be combined with sound and realistic operational practices, and supplemented, as needed, by personal strategies. Air travel will always require flexibility in operations in order to adjust to unusual and/or non-routine circumstances. From the standpoint of flight attendant fitness and well-being, it is essential that work/rest practices address the exceptions and do not become the standard. One useful reference is the "Principles and guidelines for effective duty and rest scheduling" (Dinges, Graeber, Rosekind, Samel, & Wegmann, 1996). These principles were developed for pilots but should be a useful reference for flight attendants as well.

Chapter XI. Recommendations

This report was developed with data that became available before the study's deadlines. However, it became clear that not all information needed could be acquired during the time allowed for this report and that more time and additional research could contribute to the development of a more complete understanding of the phenomenon/problem of flight attendant fatigue. Some research recommendations could be accomplished in the near term. Others would require additional time and

resources. Given the nature of the issue and the questions that remain unanswered, the following are a few suggestions offered for continued research to address the topic of flight attendant fatigue.

Survey of Field Operations. A survey of randomly-selected flight attendants could examine the rate of occurrence, and the field conditions, schedules, and practices related to flight attendant fatigue. A scientifically-based survey would assess the frequency with which fatigue is experienced, the situations in which it appears, and the consequences that follow.

Focused Study of Incident Reports. Incident reports provide a first-look at what, given different circumstances, might have become more serious events. A better understanding of the incident can be achieved by a follow-up interview. As practiced in the ASRS, an experienced analyst matching the expertise of the reporter (a former pilot, air traffic controller, mechanic, or flight attendant) engages the reporter by telephone to explore how the incident developed, what preceded it, how it was resolved, etc. This structured interview process can be directed towards a particular issue, in this case flight attendant fatigue.

Field Research on the Effects of Fatigue. Field research could explore the physiological and neuropsychological effects of fatigue, sleepiness, circadian factors, rest schedules, etc. on flight attendants. Such study would collect actigraphic data and light measurements to document flight attendants' sleep/wake schedules and exposure to zeitgeber cues from light. Flight attendants would also complete sleep diaries in order to verify estimates of sleep/wake schedules.

Validation of Models for Assessing Flight Attendant Fatigue. Reliable, predictive modeling of the effects of particular schedules on fatigue and performance would be an important tool for the aviation industry. The examples given above indicate that models offer promise for the proactive assessment of risk. Modeling provides a possible approach to understanding in advance the impact of the relevant variables. Validating the model(s) would be an important step to understanding whether and how models could be used in conjunction with field operations. This would be best accomplished by using data acquired through filed studies in conjunction with laboratory experiments.

International Policies and Practices. The present investigation concentrated on domestic airlines. However, it is likely that there is much to learn from how other countries address these issues and with what results. It would be desirable to conduct an in-depth investigation of international flights rules, regulations, and schedules in comparison with CFRs and to assess the consequences they have experienced. For example, the Australian aviation industry has implemented a fatigue risk management system (FMRS). "The basic premise of the performance-based FMRS is to allow organizations to determine acceptable controls for safety and appropriate management styles for their own circumstances, rather than imposing rigid, inflexible rules" (McCulloch, Fletcher, and Dawson, 2005). International cabin crews could also be included in studies such as the Field research on the effects of fatigue mentioned above.

Training. With sufficient knowledge and planning, it is possible in some circumstances to reduce the level of fatigue experienced. Flight crews could benefit from exposure to information on fatigue, its causes and consequences, its interaction with circadian disruption, and how and when to employ countermeasures (scheduled naps, physical activity, social interaction, caffeine, etc.). It would be useful to develop and distribute training materials for flight attendants, schedulers, and their management that could be employed individually or organizationally.

Notes

1. Reports submitted to the ASRS are on a voluntary basis. Although reports are assumed to be accurate, self-reporting bias cannot be ruled out. The value of the reports lies in the reporter's explanation of *wha*t happened and *wh*y it happened. The summarized reports do not provide an assessment of how representative the incidents reported are nor of how often these events occur. However, taken together they do provide an insight into the national airspace system that can then be further investigated.

2. These suggested areas of opportunity were provided as an aid to policy planners seeking more definitive data, since an increase in data-driven understanding of the extent of flight attendant fatigue, and factors that contribute to it increases the likelihood that changes to the system would yield desired results.

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Appendix 1. Flight Attendant Duties and Their Physical Demands

A flight attendant's job is both physically and emotionally demanding. Flight attendants are on their feet during most of the flight and under pressure to complete their tasks within the scheduled flight time. At times they have to serve meals and pour drinks under turbulent flying conditions. Despite stress or fatigue, they are expected to deal pleasantly with passengers of all personality types, including those who are difficult or rude. Although flight attendants enjoy the benefits of travel, they also may have to live out of suitcases for weeks at a time. They may be scheduled to fly at any hour, weekends and holidays. A list of flight attendant duties is provided below (Note: These duties may vary between different carriers).

1.0 GROUND DUTIES
- 1.1 Review all company issued memorandums and/or orders (I)
- 1.2 Verify currency of emergency manual (I), (S)
- 1.3 Ensure presence of company required items {cockpit key, flashlight, etc.} (Pr)
- 1.4 Attend and/or provide crew briefing (B)
- 1.5 Stow crew baggage properly (Pr)
- 1.6 Stow emergency manual properly (Pr)
- 1.7 Check emergency equipment as assigned
  CHECK OF EMERGENCY EQUIPMENT IS (Pr), (P)
  - 1.7.1 Check flight attendant jump seat and restraint system
    - 1.7.1.1 Automatic seat retraction
    - 1.7.1.2 Jump seat headrest
    - 1.7.1.3 Identify passenger seat to be used if jump seat is inoperative
    - 1.7.1.4 Check F/A panel to insure switches, controls and indicators are working
  - 1.7.2 Check portable oxygen equipment
  - 1.7.3 Check fire extinguishers
  - 1.7.4 Check first aid kits
  - 1.7.5 Check megaphones
  - 1.7.6 Check PBE's
  - 1.7.7 Check communication systems
    - 1.7.7.1 Check PA system and interphone
      - 1.7.7.1.1 Check volume control
    - 1.7.7.2 Identify call light switches
    - 1.7.7.3 Locate handset controls and indicators
    - 1.7.7.4 Identify any precautions regarding hanging up of handset
    - 1.7.7.5 Ensure chimes and chime indicator lights are working
    - 1.7.7.6 Check reset system
  - 1.7.8 Check each exit to ensure it can be readied for evacuation
  - 1.7.9 Check each slide housing to ensure slide can be readied for evacuation
  - 1.7.10 Check lavatory smoke alarm, flapper doors, and placards
  - 1.7.11 Check for flotation equipment, as required
  - 1.7.12 Check passenger seats for complete restraint systems
  - 1.7.13 Check passengers service units to ensure they are closed
  - 1.7.14 Ensure proper precautions for passenger seats and stowage on combi (sic) aircraft
  - 1.7.15 Check that class B cargo compartments are clear for crew fire fighting
  - 1.7.16 Check stowage areas for unapproved items and proper restraints
  - 1.7.17 Identify seats with removable aisle armrests for seating of handicapped
  - 1.7.18 Identify areas for placement of assist animals (sic)
- 1.8 Check safety equipment
  CHECK OF SAFETY EQUIPMENT IS (Pr), (P)
  - 1.8.1 Check presence of and prepare demonstration equipment
  - 1.8.2 Check presence of universal precaution kits
  - 1.8.3 Check presence of CPR masks

1.8.4 Check for required placards
1.8.5 Check to see that smoking signs are illuminated are posted
1.8.6 Check to see that fasten seat belt sign is properly illuminated (once turned on in cockpit) or signs are posted
1.8.7 Ensure location of seat belt extensions
1.8.8 Verify that passenger information cards are appropriate for type and model of aircraft
1.9 Complete required company documents (Wd)
1.10 Check galley equipment/components
CHECK OF GALLEY IS (Pr), (P)
1.10.1 Ensure all latches/locks work properly
1.10.2 Ensure electrical appliances (such as ovens) work
1.10.3 Ensure only approved items are stowed in ovens
1.10.4 Ensure circuit breakers are functioning properly
1.10.5 Check lower lobe galleys for proper restraints, safety equipment and working circuit breakers
1.10.6 Ensure lower lobe galley lift works properly
1.11 Check cabin systems
CHECK OF CABIN SYSTEMS IS (Pr), (P), (Wd)
1.11.1 Check circuit breakers located in the cabin
1.11.2 Check temperature and ventilation controls
1.11.3 Check lighting systems to ensure proper working condition
1.11.4 Ensure locking mechanism on lavatory doors works properly
1.12 Report safety discrepancies to the PIC (C), (D)

2. 0 BOARDING DUTIES
2.1 Assume proper station during passenger boarding (WD)
2.2 Identify possible helper passengers (V)
2.3 Implement security measures (WD), (Pr), (P), (V)
2.4 Screen passengers for acceptance according to regulation and carrier policy (Wd), (V)
2.4.1 Screen carry-on baggage for excessive size, quantity, or evidence of containing hazardous materials
2.4.2 Monitor exit seat occupants according to carrier procedure regarding stipulated criteria for seating in that seat and also evaluate occupant to determine ability to perform functions
2.4.3 Monitor unusual passenger behavior
2.4.3.1. Report passengers who appear to be intoxicated or are otherwise disruptive immediately to the PIC and customer service personnel
2.4.4 Ensure carrier procedures are followed regarding child restraint systems
2.4.4.1 Screen to ensure child restraint systems have a hard back, hard seat, and proper labels
2.4.5 Ensure carrier procedures are followed regarding lap held children
2.4.5.1 Ensure lap held children are distributed with regard to oxygen availability
2.4.5.2 Comply with carrier procedure for child flotation equipment (if applicable)
2.4.5.3 Ensure disapproved child restraint devices are not in use

3.0 PRIOR TO MOVEMENT ON THE SURFACE DUTIES
3.1 Ensure company procedures are followed regarding passenger count (V)
3.2 Conduct compliance check to ensure carry-on baggage is properly stowed COMPLIANCE CHECK IS (V), (Wd), (Da), (Ct)
3.2.1 Ensure proper closure of overhead compartments/closets
3.2.2 Ensure compartment restraints are secured for compliance with carry-on baggage regulation
3.2.3 Ensure items which may have been excluded from carry-on baggage count are stowed (e.g. purses and assistive devices)
3.2.4 Ensure canes are stowed properly

3.2.5 Ensure unusual items are stowed in accordance with air carrier's approved carry-on baggage program

3.2.6 Verify that all carry-on baggage is stowed, by assigned required crewmember

3.2.7 Follow approved method for removing carry-on baggage which cannot be stowed

3.3 Conduct appropriate passenger briefing for exit seat occupants/passengers requiring special assistance (Wd), (Ct)

3.4 Apply weight and balance procedures as directed by the PIC (C), (Ct)

3.5 Ensure doors are closed in accordance with carrier's procedures (V), (Ct)

3.6 Ensure timely arming of exits, including positioning of warning devices if part of carrier procedure, and cross check requirements, if applicable (V), (Ct), (Wd), (Da), (C)

3.7 Ensure passengers are seated (V)

3.8 Perform lavatory vacancy check (V)

3.9 Check galley security {compartments and carts}

GALLEY SECURITY CHECK HERE IS VIGILANCE (V)

3.9.1 Ensure all catering and galley supplies are stowed properly

3.9.2 Achieve compliance with compartment weight restrictions

3.9.3 Ensure latches/locks are positioned properly

3.9.4 Ensure secondary locking mechanisms are functioning properly

3.9.5 Ensure carts are secured on permanent tie downs for surface movement and take- off

3.10 Ensure proper stowage/security of movie/video screens (V)

3.11 Assume proper assignment position for safety briefing announcement or demonstration (V), (Wd)

3.12 Ensure use of electronic devices is in compliance with air carrier's procedures (V)

3.13 Signal/communicate with flight crew regarding cabin readiness for aircraft taxi (C), (D)

4.0 PRIOR TO TAKE-OFF DUTIES

4.1 Deliver safety information

DELIVERY OF SAFETY INFORMATION IS (C), (Wd), (Ct)

4.1.1 Use public address system properly

4.1.2 Provide appropriate information

4.1.2.1 Compliance with Fasten Seat Belt signs

4.1.2.2 Stowage of tray tables

4.1.2.3 Position seat backs in the upright position {leg rests retracted}

4.1.2.4 Location of emergency exits

4.1.2.5 Proper use of portable electronic devices

4.1.2.6 Stowage of carry-on baggage

4.1.2.7 Smoking restrictions

4.1.2.8 Use of oxygen {if applicable}

4.1.2.9 Availability of flotation devices

4.1.2.10 Announcement that shades must be open {in accordance with air carrier's procedure}

4.1.3 Use safety video correctly, if part of carrier's procedures

4.1.4 Ensure safety demonstration is coordinated with announcement {if applicable}

4.1.5 Give safety demonstration from approved location

4.1.6 Give safety demonstration at individual seats if passengers' view is obstructed

4.1.7 Ensure additional information regarding extended over water flights is provided {if applicable}

4.2 Perform only safety related duties during movement on the surface (V), (Wd), (Pr), (P), (D)

4.3 Perform prior to take-off compliance check

COMPLIANCE CHECK IS (V), (Wd)

4.3.1 Ensure carry-on baggage is stowed

4.3.2 Ensure infant carrying devices that are not in use are stowed properly

4.3.3 Ensure tray tables are closed and secured

4.3.4 Ensure seat backs are in the upright position {leg rests retracted}

4.3.5 Ensure seat belts are fastened

4.3.6 Ensure lap seated infants are held properly or secured in a seat
4.3.7 Ensure all galley service items have been picked up and stowed
4.3.8 Ensure galley equipment is secured
4.4 Return to flight attendant jump seat (V), (Da)
4.4.1 Don seat belt and shoulder harness (V)
4.4.2 Assume brace position {if part of company procedures} (V)
4.5 Signal/communicate with Flight Crew regarding cabin readiness for take-off (C)
4.6 Perform silent review (if part of company procedures) (V)
4.7 Comply with sterile cockpit procedures (V), (Ct), (D)

5.0 INFLIGHT DUTIES
5.1 Secure flight attendant restraint system upon leaving seat (Pr)
5.2 Provide after take-off announcement {as applicable} (Wd)
5.3 Provide seat belt announcement immediately after seat belt sign is turned off (Wd)
5.4 Provide seat belt announcement immediately whenever seat belt sign is turned on {if not performed by flight crew} (Wd), (Ct), (Lf)
5.4.1 Perform seat belt compliance check (unless turbulence is experienced) (V)
5.4.2 Communicate with flight crew regarding potential turbulence {if carrier procedure} (Lf), (C)
5.5 Follow turbulent air penetration procedures (as applicable) (V)
5.6 Ensure proper use of service carts and service equipment (V), (Wd)
5.6.1 Secure unattended carts properly
5.6.2 Engage permanent/pop up tie downs correctly
5.6.3 Secure galley compartments when not in use
5.6.4 Secure food and beverage items when not in use
5.6.5 Comply with galley lift restrictions
5.7 Follow proper alcohol service procedures (V), (Lf)
5.8 Check flight crew periodically (Wd), (Ir)
5.9 Check cabin/passengers periodically (V), (Wd)
5.10 Check lavatories periodically for potential fire hazards (V), (Wd)
5.10.1 Check for overly filled trash receptacles
5.10.2 Check for evidence of smoking
5.10.3 Ensure non-tampering of smoke detectors
5.11 Respond to passenger calls in timely manner (V)
5.12 Collect and stow service items properly (V), (Ct), (Ir), (C)
5.12.1 Stow service carts properly
5.12.2 Engage permanent/pop up tie downs correctly
5.12.3 Set brakes properly
5.12.4 Latch cart doors and utilize secondary locks {if installed}

6.0 PRIOR TO LANDING DUTIES
6.1 Secure galley compartments properly (C), (V), (Wd)
6.1.1 Close and latch all galley compartment doors
6.1.2 Set primary and secondary locks
6.2 Turn off electrical appliances not in use
6.3 Provide appropriate pre-landing announcements (C), (Wd)
6.3.1 Comply with Fasten Seat Belt signs
6.3.2 Stow tray tables
6.3.3 Place seat backs in the upright position {leg rests retracted}
6.3.4 Discontinue use of portable electronic devices,
6.3.5 Stow carry-on baggage
6.4 Comply with sterile cockpit procedures (V), (D), (C)
6.5 Perform pre-landing compliance check (V), (Wd), (Da)
6.5.1 Ensure carry-on baggage stowed

6.5.2 Ensure tray tables closed and secured
6.5.3 Ensure seat backs in the upright position {leg rests retracted}
6.5.4 Ensure seat belts fastened
6.5.5 Ensure lap seated infants held or secured in a seat
6.5.6 Ensure all child restraint systems not in use are properly stowed
6.5.7 Ensure all overhead bins and other baggage compartments are properly closed
6.5.8 Ensure movie and video screens which extend into the aisle are secured
6.6 Perform lavatory vacancy check (V), (Wd)
6.7 Perform check of exits and evacuation equipment to confirm "armed" status (V), (Wd), (Da)
6.8 Return to flight attendant jump seat (V), (C), (Da)
6.8.1 Don seat belt and shoulder harness
6.8.2 Assume brace position {if part of company procedures}
6.9 Signal/communicate with Flight Crew to indicate cabin readiness for aircraft landing {if part of carrier procedure} (C), (D)
6.10 Perform silent review {if part of company procedures} (V)

7.0 MOVEMENT ON THE SURFACE DUTIES
7.1 Provide appropriate pre-arrival announcements (Wd), (C)
7.1.1 Direct passengers to remain seated during surface movement
7.1.2 Direct non-removal of carry-on baggage until arrival at the gate
7.1.3 Include other announcements required by carrier
7.2 Perform only safety related duties during movement on the surface (V), (Da)

8.0 POST ARRIVAL DUTIES
8.1 Ensure timely disarming of exits and cross check requirements, if applicable (V), (D)
8.2 Ensure doors are opened in accordance with carrier's procedures (D), (V)
8.2.1 Disarm girt bar manually or automatically after jetway or stairs are positioned at aircraft
8.2.2 Verify girt bar disengagement
8.2.3 Open door and operate stairs {if part of equipment} in accordance with operator's procedures
8.2.4 Verify doors and airstairs are opened properly and securely latched
8.3 Monitor passenger deplaning to ensure adherence to all regulatory and company requirements (V), (Da), (Wd), (C)
8.4 Implement security procedures (Pr), (P)
8.5 Assume proper station during passenger de-planing {even distribution of flight attendants}
8.6 Turn off/check all electrical appliances {including coffee makers, ovens, video players, and all other appliances} that could pose fire hazards (V), (Da)
8.7 Ensure all passengers have left the airplane at flight termination by checking the aircraft, including lavatories (V), (Da)
8.8 Complete company required forms, including required flight reports (Wd)
8.8.1 Report problem passengers, especially if alcohol was involved (C), (Ir)
8.9 Report maintenance discrepancies {airworthiness and non-airworthiness} (C), (Ir)

9.0 INTERMEDIATE STOP DUTIES
9.1 Follow duty assignments for flight attendants at intermediate stops (Wd), (P), (Ir), (C)
9.1.1 Comply with required complement and position assignments
9.1.2 Complete duties for conducting the fueling process with passengers on board {if applicable}

10.0 FIRE CONTROL DUTIES
10.1 Recognize the problem (V)
10.1.1 Identify smoke in cabin, galleys/lower-lobe galleys, or lavatory
10.1.2 Respond to smoke detector in lavatory
10.1.3 Identify odor of fire

10.2 Locate the source of the fire (V), (Da)
  10.2.1 Identify location /source in ovens; volatile fuel vapors; light ballast; cabin furnishings; stowage bins/hat racks; trash containers; clothing; APU; jetway; ramp fires
  10.2.2 Identify class of fire {if possible}
  10.2.3 Assess the intensity of the fire {if possible}
10.3 Communicate with other crew members and initiate response coordination (C)
  10.3.1 Call flight crew to inform of fire
  10.3.2 Obtain assistance of other flight attendants {if applicable} (C), (Gc), (D), (Wd)
    10.3.2.1 Call via interphone
    10.3.2.2 Call via PA system
    10.3.2.3 Assign a passenger to locate and inform another flight attendant
10.4 Locate and retrieve the nearest PBE (Wd), (C)
  10.4.1 Remove PBE from stowage including pouch
  10.4.2 Don PBE
  10.4.3 Activate oxygen
10.5 Locate and retrieve the nearest appropriate fire extinguisher (Wd)
10.6 Approach source of fire (Wd), (Ct), (V)
  10.6.1 Use protective techniques to approach fire/smoke
  10.6.2 Maintain safe distance from fire with PBE on
10.7 Operate hand fire extinguisher (Wd), (V)
  10.7.1 Break tamper seal
  10.7.2 Remove pin (if applicable)
  10.7.3 Operate extinguisher mechanism properly
  10.7.4 Aim extinguisher and maintain it's proper attitude
10.8 Use aircraft communication system with PBE on {as necessary} (C)
10.9 Ascertain ongoing communication with flight crew (C), (Wd), (Ct)
10.10 Direct passengers to relocate away from fire location if necessary and possible
10.11 Utilize additional fire extinguishers {if necessary} (C), (Wd), (Ct)
10.12 Coordinate ongoing fire control activity with other flight attendants (Wd), (Lf)
  10.12.1 Accept replacement by another FA with PBE and extinguisher {as necessary} (Wd), (Lf), (C)
10.13 Use follow-up procedures once fire appears extinguished (Wd), (Ct)
10.14 Monitor indications that PBE is reaching time limits of operation (V)
10.15 Remove PBE as usefulness expires or need is eliminated
10.16 Position used PBE and extinguishers according to carrier procedure
10.17 Check conditions of passengers in immediate area
10.18 Report condition of fire and cabin to the flight crew
10.19 Complete required reports

11.0 DECOMPRESSION DUTIES
  11.1 Identify the symptoms associated with hypoxia (V)
  11.2 Communicate observations to other crewmembers (C)
    11.2.1 Use interphone to communicate with flight crew (C)
    11.2.2 Communicate with other flight attendants (C)
  11.3 Identify signs that decompression is or has occurred (V), (D), (Da)
    11.3.1 Don the nearest oxygen mask (Da)
    11.3.2 Fasten seat belt or hold on to something solid (Da)
    11.3.3 Wait for word from the cockpit crewmembers before moving around the cabin (Wd), (D)
  11.4 Follow post decompression duties (Wd)
    11.4.1 Obtain and carry portable oxygen bottle (Pr)
    11.4.2 Monitor condition of passengers (V), (D)
    11.4.3 Open passenger oxygen compartments that have not deployed if supplemental oxygen is needed (Pr)
  11.5 Communicate with fellow crewmembers (C)

11.6 Complete required carrier forms (Wd)

12.0 FIRST AID DUTIES
12.1 Respond to request for assistance or identify ill or injured individual in need of first aid (V), (D)
12.2 Communicate/coordinate information with other crew members (C)
12.2.1 Use interphone to communicate with flight crew
12.2.2 Use interphone, PA system or a passenger to locate and inform other flight attendants
12.3 Use proper techniques to move person to specified place on that configuration of airplane, if needed (D), (Wd), (Pr), (Ct)
12.3.1 Request assistance, if needed, from other flight attendants, passengers, or flight crew (Wd), (Ct)
12.4 Retrieve and use contents of first aid kit, as needed (Pr)
12.5 Retrieve and use components of universal precaution equipment, as needed (Pr), (Wd)
12.5.1 Comply with procedures for taking universal precautions against blood borne pathogens (V), (Da)
12.5.1.1 Use gloves, mask, eye shield and other protective gear as needed
12.5.1.2 Dispose of possibly contaminated agents
12.5.2 Report possible exposure to blood borne pathogens (V), (Da), (C)
12.6 Retrieve portable oxygen bottle, if needed (Pr), (Wd)
12.7 Request help from persons qualified to use medical kit (D), (C)
12.8 Retrieve medical kit according to carrier procedure (Pr)
12.9 Request help from ground {airline contact with medical professionals on the ground}, according to carrier procedure (D), (Wd), (C), (Ct), (Pr)
12.10 Assess condition of person who is ill or injured
12.10.1 Check for open airway
12.10.1.1 Reposition head/airway of individual, if trained and repositioning is necessary
12.10.1.2 Perform counter-choking procedure if trained and person is choking
12.10.2 Check for breathing (V), (Pr), (D)
12.10.2.1 Perform assistive breathing if trained and individual is not breathing
12.10.2.1.1 Use CPR equipment, if available
12.10.3 Check for pulse (V), (Pr), (D)
12.10.3.1 Perform CPR if trained and individual has no pulse
12.10.3.2 Use defibrillator, if trained and equipment is available
12.11 Conduct interview to obtain medical history of person who is ill or injured (C), (D), (Wd)
12.12 Perform primary survey; recognize and treat person for the following (V), (D), (Wd), (Ct)
12.12.1 Profuse bleeding {including nosebleed};
12.12.2 Chest pain
12.12.3 Burns
12.12.4 Injuries to the extremities
12.12.5 Shock
12.12.6 Unconsciousness
12.12.7 Major allergic reaction
12.12.8 Hyperventilation
12.12.9 Stroke
12.12.10 Seizures
12.12.11 Diabetic emergencies
12.12.12 Childbirth
12.12.13 Abdominal distress
12.12.14 Airsickness
12.12.15 Injuries to the skull, spine, and chest
12.12.16 Eye injury
12.12.17 Ear distress
12.12.18 Alcohol or drug abuse
12.12.19 Infectious diseases/conditions

12.12.20 Any other identifiable illness/injury, according to carrier policy

12.13 Interview the stabilized passenger or companion to obtain personal information required for reports (C), (D).

12.14 Communicate to the flight crew the condition of ill/injured passenger periodically (D), (C), (Wd).

12.15 Re-position used equipment according to carrier procedure (Pr), (Ct), (Da)

12.16 Complete required carrier forms (Pr), (Wd)

13.0 PROBLEM PASSENGER DUTIES

13.1 Perform duties to prevent passengers appearing to be intoxicated from traveling (V), (C), (Wd), (Ct)

13.1.1 Screen and identify passengers appearing to be intoxicated

13.1.1.1 Screen passengers during boarding

13.1.1.2 Monitor passenger conduct during flight

13.1.1.2.1 Inform passenger of regulatory requirements and carrier policies as needed

13.1.1.2.2 Communicate with flight crew immediately to report non-compliant passengers

13.1.2 Provide alcohol service according to carrier procedures

13.2 Perform duties to identify and manage potential problem passengers who could threaten safety of the flight/passengers/crew (V), (D), (C), (Wd), (Ct)

13.2.1 Screen and identify potential problem passengers during boarding

13.2.2 Question passengers regarding suspect baggage on board an aircraft

13.2.2.1 Recognize hazardous materials labels

13.2.2.2 Report hazardous materials to the flight crew (C)

13.2.3 Monitor lavatories periodically (V), (Wd), (Ct)

13.2.4 Perform cabin checks periodically (V), (Wd), (Ct)

13.2.4.1 Monitor passenger conduct

13.2.5 Address incidents of non-compliance immediately with potential problem passenger (C), (D), (Wd)

13.2.5.1 Inform passenger of regulatory requirements and carrier policies

13.2.6 Manage disruptive or problem passengers by using a team approach or specific carrier techniques designed to defuse such situations (D), (Gc), (Wd)

13.2.6.1 Communicate with flight crew immediately to report non-compliant passengers (V), (D), (C), (Da)

13.2.6.2 Coordinate with other flight attendants regarding team concept problem management (C), (Lf), (Wd)

13.2.6.3 Communicate with PIC; comply with carrier procedures regarding involvement of law enforcement officials, if necessary (C), (Wd), (Ir)

13.2.6.4.Restrain violent passengers as indicated in carrier procedures (V), (D), (Gc)

13.2.6.4.1 Obtain assistance from other crewmembers and/or passengers

13.2.6.4.2 Use appropriate equipment provided by the carrier

13.3 Complete all required carrier forms (Pr)

14.0 EVACUATION AND DITCHING DUTIES

Conduct A Forewarned Evacuation

14.1 Communicate with PIC when called to flight deck to obtain essential information (C)

14.1.1 Find out how much time there will be until landing

14.1.2 Find out what type of landing is anticipated (i.e. on runway, gear down, gear up, windy, which doors can be used)

14.1.3 Establish signal to assume brace for impact position

14.2 Coordinate with flight attendants {if applicable} (C), (Wd), (Gc), (D), (B)

14.3 Prepare passengers (C), (Wd), (Gc), (D)

14.3.1 Instruct passengers on brace for impact position

14.3.2 Instruct passengers regarding release of seat belt

14.3.3 Conduct passenger review of passenger information card
14.3.4 Instruct passengers on location of exits
14.3.5 Brief helper passengers on tasks
14.3.5.1 Open door/window exit
14.3.5.2 Assist crewmembers
14.3.5.3 Hold passengers back until exit is open and readied
14.3.5.4 Help at bottom of slide
14.3.5.5 Evacuate crewmember at your door, if crewmember is incapacitated
14.3.5.6 Assist passengers who may need help
14.3.5.6.1 Unaccompanied minors
14.3.5.6.2 Mothers with small children
14.3.5.6.3 Disabled passengers
14.3.5.6.4 Passengers exhibiting great fear
14.3.5.6.5 Passengers who may be hurt because of impact
14.3.5.6.6 Other passengers who may need help
14.4 Prepare cabin (Da), (Wd), (Ct)
14.4.1 Stow galley supplies
14.4.2 Ensure all galley components are properly restrained
14.4.3 Stow all carry-on baggage
14.4.4 Stow loose items
14.4.5 Lock lavatories
14.5 Prepare for landing (V), (Da), Wd), (C)
14.5.1 Complete compliance check for passenger seat belts fastened and everything stowed
14.5.2 Provide last minute instructions to passengers
14.5.3 Check exits to ensure they are ready for evacuation
14.5.4 Use proper techniques to fasten flight attendant restraint system
14.5.5 Inform PIC of cabin readiness
14.5.6 Assume flight attendant protective brace position
14.5.7 Instruct passengers to assume protective brace position
14.6 Perform assigned duties following impact (C), (D), (Gc), (V)
14.6.1 Coordinate with other crewmembers
14.6.2 Open seat belts
14.6.3 Assess conditions
14.6.4 Activate emergency lights
14.6.5 Initiate evacuation using communication protocols and noting that decision may be made not to evacuate
14.6.6 Activate evacuation signal
14.6.7 Shout commands to passengers (e.g. “Open seat belts” “Come this way’)
14.6.8 Secure safety strap if appropriate
14.6.9 Conduct evacuation at floor level exits (V), (D)
14.6.9.1 Apply forces necessary to open door in emergency mode and under possible adverse conditions
14.6.9.2 Take appropriate precautions for door hazard conditions
14.6.9.3 Hold onto assist handle
14.6.9.4 Open the exit in the armed mode
14.6.9.5 Use manual operation if pneumatic operations fail
14.6.9.6 Secure the exit in the fully open position
14.6.9.7 Pull the manual inflation handle{s} and verify deployment, inflation {e.g. ramp, slide}
14.6.9.8 (in the case of stairs, ensure they are positioned for evacuation)
14.6.9.9 Maintain appropriate protective body and hand positions
14.6.9.10 Use evacuation signal {could be evacuation alarm, chime signal or other}
14.6.9.11 Shout door commands to passengers {e.g. “Come this way” “Jump”}
14.6.9.12 Use passenger flow management control
14.6.9.12.1 Direct passengers to most useable doors

14.6.9.13 Give commands to helpers

14.6.10 Conduct evacuation at over wing exits. (V), (D), (Wd)
14.6.10.1 Go to exit (if part of assigned duties)
14.6.10.2 Remove hatch
14.6.10.3 Dispose of hatch in approved manner
14.6.10.4 Give commands to passengers on how to egress through exit {i.e. leg, body, leg}
14.6.10.5 Control passenger flow at over wing area
14.6.10.6 Use escape ropes {if aircraft so equipped}
14.6.10.7 Ensure evacuation of passengers needing assistance
14.6.10.8 Shout commands to helpers at the bottom of the slides {if aircraft so equipped}
14.7 Perform assigned duties following evacuation (C), (Wd), (Gc)
14.7.1 Take care of surviving passengers
14.7.2 Gather passengers in a group, if possible
14.7.3 Render first aid
14.7.4 Stay with passengers until ground service personnel arrive
14.7.5 Practice survival techniques in accordance with terrain on which landing occurred (i.e., desert, jungle, water, arctic)
Conduct An Unforewarned Evacuation
14.8 Perform assigned duties following impact
14.8.1 Coordinate with other crewmembers (C), (D), (V).
14.8.2 Open seat belts
14.8.3 Assess conditions (V), (D)
14.8.4 Activate emergency lights
14.8.5 Initiate evacuation using communication protocols and noting that decision may be made not to evacuate
14.8.6 Activate evacuation signal
14.8.7 Shout commands to passengers {e.g. "Open seat belts" "Come this way"} (Gc), (C), (Da)
14.8.8 Secure safety strap if appropriate
14.8.9 Conduct evacuation at floor level exits (V), (D)
14.8.9.1 Apply forces necessary to open door in emergency mode and under possible adverse conditions
14.8.9.2 Take appropriate precautions for door hazard conditions
14.8.9.3 Hold onto assist handle
14.8.9.4 Open the exit in the armed mode
14.8.9.5 Use manual operation if pneumatic operations fail
14.8.9.6 Secure the exit in the fully open position
14.8.9.7 Pull the manual inflation handle{s} and verify deployment, inflation {e.g. ramp, slide}
14.8.9.8 {in the case of stairs, ensure they are positioned for evacuation}
14.8.9.9 Maintain appropriate protective body and hand positions
14.8.9.10 Use evacuation signal {could be evacuation alarm, chime signal or other}
14.8.9.11 Shout door commands to passengers {e.g. "Come this way" "Jump"}
14.8.9.12 Use passenger flow management control
14.8.9.12.1 Direct passengers to most useable doors
14.8.9.13 Give commands to helpers
14.8.10 Conduct evacuation at wing exit (V), (D), (Wd)
14.8.10.1 Go to exit (if part of assigned duties)
14.8.10.2 Remove hatch
14.8.10.3 Dispose of hatch in approved manner
14.8.10.4 Give commands to passengers on how to egress through exit {i.e. leg, body, leg}
14.8.10.5 Control passenger flow at over wing area
14.8.10.6 Use escape ropes {if aircraft so equipped}
14.8.10.7 Ensure evacuation of passengers needing assistance

14.8.10.8 Shout commands to helpers at the bottom of the slides {if aircraft so equipped}

14.9 Perform assigned duties following evacuation (C), (Wd), (Gc)

14.9.1 Take care of surviving passengers

14.9.2 Gather passengers in a group, if possible

14.9.3 Render first aid

14.9.4 Stay with passengers until ground service personnel arrive

14.9.5 Practice survival techniques in accordance with terrain on which landing occurred {i.e. desert, jungle, water, arctic}

Conduct A Forewarned Water Landing (Ditching)

14.10 Communicate with PIC when called to flight deck to obtain essential information (C)

14.10.1 Find out how much time there will be until landing

14.10.2 Find out what type of landing is anticipated (i.e. water conditions, weather conditions, which doors can be used)

14.10.3 Establish signal to assume brace for impact position

14.11 Coordinate with flight attendants {if applicable} (C), (Wd), (Gc), (D), (B)

14.12 Prepare passengers (C), (Wd), (Gc), (D)

14.12.1 Instruct passengers on brace for impact position

14.12.2 Have passengers don life vest and instruct them on use

14.12.3 Don a crew life vest

14.12.4 Instruct passengers regarding release of seat belt

14.12.5 Conduct passenger review of passenger information card

14.12.6 Instruct passengers on location of exits

14.12.7 Brief helper passengers on tasks

14.12.7.1 Open door/window exit

14.12.7.2 Assist crewmembers

14.12.7.3 Hold passengers back until exit is open and readied

14.12.7.4 Help in raft or slide/raft as directed

14.12.7.5 Evacuate crewmember at your door, if crewmember is incapacitated

14.12.7.6 Assist passengers who may need help

14.12.7.6.1 Unaccompanied minors

14.12.7.6.2 Mothers with small children

14.12.7.6.3 Disabled passengers

14.12.7.6.4 Passengers exhibiting great fear

14.12.7.6.5 Passengers who may be hurt because of impact

14.12.7.6.6 Other passengers who may need help

14.12.7.7 Have passengers put on clothes as outside conditions warrant

14.12.7.8 Instruct passengers to inflate life vests if air carrier's procedure

14.13 Prepare cabin (V), (Da), (Wd), (C)

14.13.1 Stow galley supplies

14.13.2 Ensure all galley components are properly restrained

14.13.3 Stow all carry-on baggage

14.13.4 Stow loose items

14.13.5 Lock lavatories

14.13.6 Prepare raft or brief helpers on positioning raft according to carrier procedures

14.13.7 Transfer slide/raft from one door to another if needed

14.13.8 Brief helpers on use of slide/raft as raft

14.13.9 Brief helpers on launching raft or slide/raft

14.13.9.1 Include information on launching and other actions necessary to prepare it for use as a raft

14.13.10 Brief helpers on use of location devices and survival kit and other actions as directed by company procedures

14.14 Prepare for landing (V), (Da), (Wd), (C)

14.14.1 Complete compliance check for passenger seat belts fastened and everything stowed

14.14.2 Provide last minute instructions to passengers

14.14.3 Check exits to ensure they are ready for evacuation
14.14.4 Use proper techniques to fasten flight attendant restraint system
14.14.5 Assume flight attendant protective brace position
14.14.6 Command passengers to assume protective brace position
14.15 Perform assigned duties following impact (C), (Wd), (Gc)
14.15.1 Coordinate with other crewmembers
14.15.2 Open seat belts
14.15.3 Assess conditions {watch for water line}
14.15.4 Activate emergency lights
14.15.5 Initiate evacuation using communication protocols and noting that decision may be made not to evacuate
14.15.6 Activate evacuation signal
14.15.7 Shout commands to passengers {example, open seat belts come this way}
14.15.8 Secure safety strap if appropriate
14.15.9 Conduct evacuation at floor level exits (V), (D)
14.15.9.1 Apply forces necessary to open door in emergency mode and under possible adverse conditions
14.15.9.2 Take appropriate precautions for door hazard conditions
14.15.9.3 Hold onto assist handle
14.15.9.4 Open the exit in the armed mode
14.15.9.5 Use manual operation if pneumatic operations fail
14.15.9.6 Secure the exit in the fully open position
14.15.9.7 Pull the manual inflation handle{s} and verify deployment, inflation
14.15.9.8 Deploy inflated slide and launch rafts if aircraft equipped with life rafts
14.15.9.9 Evacuate passengers into raft, slide/raft, or water
14.15.9.10 Maintain appropriate protective body and hand positions
14.15.9.11 Use evacuation signal {could be evacuation alarm, chime signal or other}
14.15.9.12 Shout door commands to passengers {e.g. "Run into slide raft" and "Inflate vest"}
14.15.9.13 Use passenger flow management control
14.15.9.13.1 Direct passengers to most useable doors
14.15.9.14 Give commands to helpers
14.15.9.15 Ensure evacuation of passengers needing assistance
14.15.9.16 Inflate crew life vest
14.15.10 Conduct evacuation over wing exit (V), (D), (Wd)
14.15.10.1 Go to exit (if part of assigned duties)
14.15.10.2 Remove hatch
14.15.10.3 Dispose of hatch in approved manner
14.15.10.4 Launch rafts in over wing area (Wd), (Ir), (C)
14.15.10.5 Use life lines
14.15.10.6 Give commands to passengers on how to egress through exit {i.e. leg, body, leg}
14.15.10.7 Control passenger flow at over wing area
14.15.10.8 Ensure evacuation of passengers needing assistance
14.15.10.9 Shout commands to helpers in raft
14.15.11 Use water survival techniques in rafts (C), (D), (V), (Lf)
14.15.11.1 Distribute the load
14.15.11.2 Retrieve, inventory and secure survival kit
14.15.11.3 Try to find other survivors
14.15.11.4 Get clear of fuel-covered water in case the fuel ignites
14.15.11.5 Remain tethered to a/c as long as practical
14.15.11.6 Get clear and upwind of aircraft as soon as practical, but stay in vicinity until aircraft sinks
14.15.11.7 Deploy sea anchor once you are released from aircraft {or rig a sea anchor}

14.15.11.8 Check raft inflation
14.15.11.9 Repair leaks
14.15.11.10 Decontaminate the raft of all fuel
14.15.11.11 Avoid jagged or sharp debris, surface oil, burning surface oil in water
14.15.12 Use water survival techniques without rafts (C), (D), (V), (Lf)
14.15.12.1 Use slide as a flotation device
14.15.12.2 Place injured on top {do not overload}
14.15.12.3 Assist survivors with seat cushion or life vest as flotation device
14.15.12.4 Instruct survivors in use of HELP and/or HUDDLE positions

Conduct An Inadvertent Water Landing Evacuation

14.16 Coordinate with other crewmembers (C), (D), (V)
14.17 Open seat belts
14.18 Assess conditions {watch for water line} (V), (D)
14.19 Activate emergency lights
14.20 Initiate evacuation using communication protocols and noting that decision may be made not to evacuate
14.21 Activate evacuation signal
14.22 Don crew life vest
14.23 Shout commands to passengers {e.g. "Open seat belts" "Come this way" "Grab life vest" or "Grab seat cushion", as applicable}
14.24 Secure safety strap if appropriate
14.25 Conduct evacuation at floor level exit (V), (D)
14.25.1 Apply forces necessary to open door in emergency mode and under possible adverse conditions
14.25.2 Take appropriate precautions for door hazard conditions
14.25.3 Hold onto assist handle
14.25.4 Open the exit in the armed mode
14.25.5 Use manual operation if pneumatic operations fail
14.25.6 Secure the exit in the fully open position
14.25.7 Pull the manual inflation handle{s} and verify deployment, inflation
14.25.8 Deploy inflated slide and launch rafts if aircraft equipped with life rafts
14.25.9 Evacuate passengers into raft, slide/raft, or water
14.25.10 Maintain appropriate protective body and hand positions
14.25.11 Use evacuation signal {could be evacuation alarm, chime signal or other}
14.25.12 Shout door commands to passengers {e.g. "Run into slide raft"}
14.25.13 Use passenger flow management control
14.25.13.1 Direct passengers to most useable doors
14.25.14 Ensure evacuation of passengers needing assistance
14.25.15 Give commands to helpers
14.26 Conduct evacuation over wing exit (V), (D), (Wd)
14.26.1 Go to exit {if part of assigned duties}
14.26.2 Remove hatch
14.26.3 Dispose of hatch in approved manner
14.26.4 Launch rafts in over wing area (Wd), (Ir), (C)
14.26.5 Use life lines
14.26.6 Give commands to passengers on how to egress through exit {i.e., leg, body, leg}
14.26.7 Control passenger flow over wing area
14.26.8 Ensure evacuation of passengers needing assistance
14.26.9 Shout commands to helpers in raft
14.27 Use water survival techniques in rafts (C), (D), (V), (Lf)
14.27.1 Distribute the load
14.27.2 Retrieve, inventory and secure survival kit
14.27.3 Try to find other survivors
14.27.4 Get clear of fuel-covered water in case the fuel ignites

14.27.5 Remain tethered to a/c as long as practical
14.27.6 Get clear and upwind of aircraft as soon as practical, but stay in vicinity until aircraft sinks
14.27.7 Deploy sea anchor once you are released from aircraft {or rig a sea anchor}
14.27.8 Check raft inflation
14.27.9 Repair leaks
14.27.10 Decontaminate the raft of all fuel
14.27.11 Avoid jagged or sharp debris, surface oil, burning surface oil in water

14.28 Use water survival techniques without rafts (C), (D), (V), (Lf)
14.28.1 Slide as a flotation device.
14.28.2 Place injured on top (do not overload)
14.28.3 Assist survivors with seat cushion or life vest as flotation device
14.28.4 Instruct survivors in use of HELP and/or HUDDLE positions

Control An Unwarranted (Unneeded) Evacuation

14.29 Take protective position if at door (V), (D)
14.30 Crew coordination (C)
14.31 Stop evacuation; use strong commands {e.g. "Stop" "Remain seated"} (Lf)
14.32 Care for passengers following the evacuation (C), (Wd), (Gc)

15.0 AIR CARRIER CULTURE DUTIES

15.1 Comply with carrier's policy regarding authority of the pilot-in-command (Lf), (D)
15.2 Comply with carrier's policy regarding chain of command as it may be specific to each aircraft (Lf), (D)
15.3 Manage exposure to radiation risks by taking appropriate action in accordance with air carrier's procedures (Pr), (V)
15.4 Comply with regulations and carrier procedures regarding passengers needing special assistance (Pr)
15.4.1 Follow procedures for handling of onboard wheelchairs
15.4.2 Use proper methods for moving passengers with physical limitations, including stretcher patients and infants in incubators
15.4.3 Follow procedures for special aircraft accommodations
15.4.3.1 Accessible lavatories
15.4.3.2 Moveable armrests

15.5 Comply with carrier procedures for handling each type of passenger requiring focused attention or special safety briefings (V), (C), (Ct), (Pr)
15.5.1 Passengers with communication difficulties such as those not proficient in speaking the language of the carrier
15.5.2 Passengers with a vision or hearing disability
15.5.3 Passengers with service animals
15.5.4 Passengers who appear to be mentally retarded
15.5.5 Armed passengers
15.5.6 Escorts
15.5.7 Prisoners
15.5.8 Couriers
15.5.9 VIP's
15.5.10 Deportees
15.5.11 Runaways
15.5.12 Persons Traveling Without Visas
15.5.13 Other designated unescorted individuals including unaccompanied minors

15.6 Comply with CFR's pertinent to flight attendant duty restrictions and rest provisions (Pr)
15.7 Comply with CFR's and company policy regarding use of drugs and alcohol (Pr)
15.8 Comply with CFR's and company policy regarding drug and alcohol testing (Pr)
15.9 Comply with CFR's and company policy regarding admission to the flight deck (Pr)
15.10 Comply with CFR's and company policy regarding manipulation of controls (Pr)

15.11 Comply with CFR's and company policy regarding carriage of cargo in passenger compartment (Pr)
15.12 Comply with air carrier procedures for interaction with officers/agents of various governmental agencies (Pr)

NOTE 1:
Flight attendants open exits during emergency evacuation/ditching for which they are assigned responsibility by the carrier's procedures or for which they become responsible as a result of conditions of the occurrence. Proper preparation for these duties includes opening each type of exit, in emergency mode, of each aircraft on which the flight attendant is qualified, during initial, recurrent, and transition training.

NOTE 2:
Crew Resource Management {CRM} markers are noted in abbreviation within parenthesis ( ) after each applicable task.
Where tasks have a list of sub-components, each of which requires or demonstrates the same CRM marker{s}, the markers are noted after the task, above the list of sub-components.

The Abbreviations Key is:

(B) Briefing
(C) Communication
(Ct) Concern for Tasks
(D) Decisions
(Da) Distractions Avoided
(Gc) Group Climate
(I) Inquiry
(Ir) Interpersonal Relationships
(Lf) Leadership Followership
(P) Planning
(Pr) Preparation
(S) Self Critique
(V) Vigilance

PHYSICAL DEMANDS:
As one example of these, please refer to the following:
[www.unitedafa.org/cmt/occ/pkg/JobDescriptionAFA.pdf].

<u>Standing & Walking</u>:
-occurs continually throughout the flight; may occur in one place very frequently, usually for short periods of time up to 10 mins.
-in combination with walking, can occur up to 95% of the time; frequently occurs concurrently with reaching, twisting/turning or pushing/pulling.
-frequently occurs when aircraft is not level.
-may occur during turbulence &/or walking in the galley occurs continuously up to 5 hours.
<u>Sitting</u>:
-occurs during briefing; may occur during delays.
-usually does not occur on flights of 1 hour or less; may occur after food & beverage services are completed on longer flights.
<u>Kneeling</u>:
-is optional to bending or stooping.
<u>Walking</u>:
-distances of up to 100 feet occur very frequently when on board.
-frequently occurs when aircraft is not level; may occur during turbulence.
-distances over 100 yards may occur in airports.
-during food/beverage services occurs concurrently w/ pushing /pulling heavy objects
<u>Lifting</u>:
-objects weighing up to 10 pounds may occur very frequently.

-objects weighing 11-25 pounds occurs occasionally.
-objects weighing more than 25 pounds occur occasionally.
-objects weighing more than 40 lbs very infrequently.
-In emergencies, flight attendants may need to lift/maneuver/pivot over wing window exit doors onto the seats. The 767 window hatches weigh 59 lbs.
Weights of other items, which could be lifted:

-Bin of 25 cans of soda:	23 lbs
-Bin of 6 bottles of champagne:	24 lbs
-Bin of 40 milks:	24 lbs
-Pot of coffee (full):	4 lbs
-Meal rack with 10 entrees:	14 lbs
-Oxygen cylinders:	15 lbs

<u>Carrying:</u>
-personal luggage to & from aircraft occurs each trip.
-objects weighing up to 10 lbs distances of 100 feet occurs frequently & continually throughout a flight.
-objects weighing up to 40 lbs up to 100 feet may occur infrequently.
-up or down an incline is necessary when aircraft is not level.
-personal luggage, may occasionally occur when climbing a flight of stairs.

<u>Climbing:</u>
-a flight of stairs to & from aircraft occasionally.
-circular stairs to second level of 747 is occasionally necessary.
<u>Bending/Squatting</u>:
-to all levels occurs very frequently & continually throughout a flight.
-slightly forward at waist level occurs when speaking with passengers, serving beverages & food.
-1 to 18 inches from floor occurs repeatedly when serving beverages & food from a cart
-can occur concurrently w/ twisting/turning, reaching or pushing /pulling.
-to floor level occurs occasionally.
-is necessary to reach lower drawers & cabinets in galley.
-is necessary when arming/disarming aircraft doors.
<u>Pushing/Pulling</u>:
-occurs frequently & continually during a flight.
-occurs when moving a cart, which could weigh up to 250 lbs.
-food or beverage cart up or down an incline is necessary if aircraft is not level.
-is necessary when assisting w/ tray tables, opening galley cabinets & drawers, using 747 elevators or serving from food & beverage carts.
-may occur concurrently w/ reaching/bending.
<u>Reaching</u>:
-overhead to galley cabinets, magazine racks or storage bin occurs occasionally.
-can occur repeatedly prior to take-off & after landing.
-at waist-level can occur frequently during a flight, and below the waist occurs frequently when serving from carts. Below the waist occurs repeatedly when placing or removing food & beverage item from tray tables.
-can occur concurrently w/ bending, pushing/pulling or twisting /turning.
<u>Twisting/Turning</u>:
-can occur frequently & concurrently throughout a flight.
-can occur concurrently w/ reaching &/or bending.

STRESSORS:
<u>Time</u>:

being late for an assigned flight has greater consequences than most jobs.
unevenly distributed work load--when delays occur, waiting time in which little is

required can be several hours in duration. Conversely, beverage service on a short flight is time-pressured.
in a flight delay, transferring from one flight to another can be problematic.

<u>Space</u>:

functioning in a limited amount of space.
traversing cabin aisles when passengers are standing & leaning in the aisles.
working in a small galley w/ at least one other flight attendant.
working in a 747 galley requires use of a one-person elevator.
working in a 747 galley involves up to 5 hours in an area approximately 6'3" high, 4" wide & 30" long.

<u>Passengers</u>:

passengers becoming physically or verbally abusive.
passengers significantly increasing work load w/ multiple or inappropriate requests.
passengers refusing to follow regulations or accept company policies
passenger complaints about delays, etc.

<u>Emergency Situations</u>:

passengers becoming ill or injured, particularly in life-threatening situations.
passengers or crew member in life-threatening situation.
threatened or actual highjacking or aircraft.
emergency landings, turbulence or loss of cabin pressure.

<u>Other</u>:

inadequate food/beverage supplies
malfunctioning equipment.

SOME EXAMPLES FOR WEIGHTS ON DIFFERENT A/C TO BE HANDLED BY FLIGHT ATTENDANTS:

A) DOORS

B-737-727 Fleet
- 5 lbs to lift handle
-20 lbs to rotate handle
-75 lbs to push door out
-10 lbs to lift windows and roll it onto seat
-45 lbs weight of window

B-757-200
-10 lbs to lift handle
-40 lbs to rotate handle
-15 lbs to lift window and roll it onto seat
-53 lbs weight of window

B-767-200-300
-23 lbs of pressure to arm door
-20 lbs of pressure to lift handle
-54 lbs weight to lift window & move

A-320
-20 lbs of pressure to arm door
-18 lbs to lift window & roll onto seat

B-747-100-400
-15 lbs of pressure to lift & rotate handle of doors

747-400 gull wing doors in upper deck
-27 lbs to lift large handle
-50 lbs to push slide pack out of door

B) BOARDED WEIGHT OF SERVICE CARTS (when cart is fully loaded)

B-747 Liquor Cart		230 lbs
777/767/747 Duty Free Cart		187 lbs
	Tray cart	122 lbs
	9 Rack Entree Cart	216 lbs
	Hi Tech Food Cart	182 lbs
B-737-300	New Tech Cart	185 lbs
	1/Liquor miniature tray	9 lbs
	1/Metal bin soft drinks	21 lbs
	1/Metal bin orange juice cartons	22 lbs
	1/Entree rack w/ frozen entrees	16 lbs

C) MISC WEIGHT

Trays C/class	3.6 lbs
Y/class	2.5 lbs

Appendix 2. Categories and Variables Associated With Fatigue

Categories associated with fatigue (A) and variables that relate to these categories (B).

A	B
Sleep factors	Sleep quality and sleep length Departure time (night vs. day time)
Circadian rhythm factors	Number of time zones crossed Light exposure (seasonal) Direction of flight Homebound vs. outbound Duration of layovers and sleep quality
Crew factors	Length of service Schedule difficulty (seniority bid factor) High workload factors Duty time (short-haul vs. long-haul) Cockpit vs. cabin Amount of walking required Service class (economy vs. first class or business class)
Individual factors	Age Gender Morningness-eveningness type Personality (extrovert-introvert) Initial fatigue level before duty Food consumption
Aircraft factors	Airline Aircraft factors: aircraft model, attitude (incline), fuselage trim and oscillations Noise Altitude
Medical, physical, or psychological conditions associated with fatigue or sleep loss	Various physical problems (sinus problems, dehydration, headaches, muscle cramps) Personal issues or domestic situations Emotional tension Sick leave and absenteeism Post Traumatic Stress Syndrome

Appendix 3.
Flight attendant schedule duty times, total flight time, layover duration, and time zone per day, sorted by carrier; N = 122.

Carrier	Home Time Zone (TZ)	Day 1 Start	Day 1 End	Day 1 Total Flight	Day 1 Layover	Day 1 TZ	Day 2 Start	Day 2 End	Day 2 Total Flight	Day 2 Layover	Day 2 TZ	Day 3 Start	Day 3 End	Day 3 Total Flight	Day 3 Layover	Day 3 TZ	Day 4 Start	Day 4 End	Day 4 Total Flight	Day 4 TZ
D	C	15:57	23:03	5:20	8:00	M	7:00	20:47	9:13		C									
D	C	16:07	20:14	3:00	10:52	C	6:58	20:58	9:17	8:43	E	5:34	13:05	6:09		C				
D	C	16:08	20:44	3:21	10:22	C	7:03	20:58	8:19	8:22	E	5:15	12:46	6:11		C				
D	C	16:08	20:24	3:01	10:42	C	7:04	20:45	9:07	8:56	E	5:39	15:46	8:41		C				
D	C	16:10	0:40	5:28	13:45	M	14:25	2:12	7:24	15:48	M	18:00	1:11	4:49	8:49	P	10:00	19:13	1:49	C
D	E	16:15	22:54	6:18	8:57	M	7:59	23:02	8:10		E									
D	M	16:19	22:08	2:31	12:47	P	10:55	22:37	5:42	9:38	P	8:15	23:21	5:11	8:29	C	7:50	11:40	2:47	M
D	P	17:16	2:50	5:20	8:00	E	10:47	14:37	6:21		P									
D	C	17:20	6:03	7:27	14:02	C	20:05	5:50	7:22	24:10:00	C	6:00	13:45	5:41	15:51	C	5:35	17:59	8:08	C
D	M	17:35	2:07	3:45	8:00	P	10:07	22:55	5:48		M									
D	E	17:39	22:05	3:21	8:10	E	6:27	16:07	6:56		E									
D	E	17:56	22:13	3:35	17:32	P	18:23	7:01	10:29	8:44	P	16:01	5:11	10:29	16:19	P	21:15	6:43	3:06	E
D	C	17:59	21:54	3:40	9:54	M	7:49	21:57	8:23	8:39	C	6:32	18:30	8:11		C				
D	C	17:59	23:02	3:01	9:22	E	8:15	21:41	10:41	8:14	C	5:50	18:17	8:44		C				
D	P	18:00	0:50	1:20	13:10	P	14:00	23:17	9:11	9:43	P	9:00	0:02	3:49		P				
D	C	18:00	23:46	3:31	17:18	E	17:18	23:20	6:47	8:00	M	7:16	0:45	12:10		C				
D	C	18:31	23:13	4:17	8:17	M	7:22	21:09	8:18		C									
D	C	19:10	8:01	7:14	10:29	E	18:30	6:17	7:23		C									
D	M	19:29	21:16	1:23	10:59	P	8:15	22:31	10:43	8:00	P	6:31	19:42	9:12		M				
D	C	20:16	0:18	4:47	8:00	P	7:53	23:14	9:19		C									
D	P	21:05	6:25	5:05	9:35	E	15:58	20:03	6:02		P									
D	P	22:04	7:11	5:04	8:49	E	16:00	20:16	6:02		P									
LC	E	6:00	13:30	4:03	15:20	E	4:50	16:09	7:57	14:06	E	6:15	15:23	6:57		E				
LC	E	6:55	14:00	5:39	14:50	C	4:50	10:12	3:29	20:08	C	6:20	20:00	9:53		E				
LC	E	6:55	14:00	5:39	14:50	C	4:50	10:12	3:29	20:08	C	6:20	20:00	9:53		E				
LC	E	6:55	16:03	6:48	16:12	E	8:15	21:05	8:21	11:25	E	8:30	20:25	9:02		E				
LC	E	6:55	13:18	4:33	18:57	E	8:15	21:05	8:35	11:10	E	8:15	16:02	5:18		E				
LC	E	7:00	18:00	8:30	11:40	C	5:40	13:48	5:21	17:12	C	7:00	14:38	6:03	15:47	C	6:25	17:25	7:47	E
LC	E	7:00	13:04	4:09	17:11	E	6:15	16:00	7:25	13:05	E	5:05	16:03	8:18	13:07	E	5:10	16:58	8:21	E
LC	E	7:00	15:55	8:27	11:20	E	7:15	14:50	5:10	15:25	E	6:15	14:30	6:00	17:00	E	7:30	20:29	8:04	E
LC	E	7:15	16:26	7:29	14:34	C	7:00	19:10	7:58		E									
LC	E	9:15	21:53	9:25	13:53	E	11:46	21:27	7:17		E									
LC	E	11:15	19:49	5:07	10:26	E	6:15	15:17	6:15	13:33	E	4:50	12:28	5:21		E				
LC	E	12:00	0:53	8:35	13:39	E	14:32	22:16	6:21	18:33	C	16:49	20:40	1:51		E				
LC	E	12:09	0:54	8:58	15:13	E	16:07	22:20	4:38	17:34	E	15:54	21:39	4:05		E				
LC	E	12:34	0:46	9:57	13:20	C	14:06	22:03	5:20	20:07	E	18:10	20:40	1:31		E				
LC	E	13:40	22:08	5:39	16:04	E	14:12	21:10	7:49	14:04	P	11:15	13:25	4:10		E				
LC	E	14:14	20:05	3:56	10:45	E	6:50	13:50	5:20	15:30	E	5:20	13:14	5:29		E				
LC	E	14:14	20:05	3:56	10:45	E	6:50	13:50	5:20	15:30	E	5:20	13:14	5:25		E				
LC	E	14:15	22:15	6:20	18:33	C	16:49	0:23	4:04	13:07	C	13:30	22:30	5:43		E				
LC	E	14:32	22:29	6:30	17:27	C	15:56	23:16	4:07	12:27	E	11:43	21:03	7:00	10:12	E	7:15	16:29	5:58	E

Carrier	Home Time Zone (TZ)	Day 1 Start	Day 1 End	Day 1 Total Flight	Day 1 Layover	Day 1 TZ	Day 2 Start	Day 2 End	Day 2 Total Flight	Day 2 Layover	Day 2 TZ	Day 3 Start	Day 3 End	Day 3 Total Flight	Day 3 Layover	Day 3 TZ	Day 4 Start	Day 4 End	Day 4 Total Flight	Day 4 TZ
LC	E	14:32	22:29	6:30	17:27	C	15:56	23:01	3:42	13:52	E	12:53	20:37	5:29		E				
LC	E	14:45	21:55	5:27	18:55	C	16:50	0:24	4:01	18:45	C	19:09	5:50	4:05		E				
LC	E	14:55	20:40	4:15	10:15	E	6:55	12:40	4:10	16:10	E	4:50	12:19	5:23		E				
LC	E	14:55	20:40	8:22	11:47	E	6:55	12:40	8:17		E									
LC	E	14:55	23:01	5:05	13:52	E	12:53	22:24	7:53	18:11	C	16:35	20:35	2:00		E				
LC	E	15:15	22:29	5:43	17:27	C	15:56	23:01	3:42	13:52	E	12:53	20:37	5:29		E				
LC	E	15:20	23:13	8:21	18:17	C	17:30	22:42	4:25	15:53	M	14:35	20:25	2:50		E				
LC	E	16:00	22:58	4:33	16:42	E	15:40	22:15	4:55	10:00	E	8:15	14:58	4:18		E				
LC	E	16:10	22:34	4:39	17:06	E	15:40	20:55	3:40	10:25	E	7:20	16:48	7:10		E				
LC	E	16:20	0:36	5:53	13:25	E	14:01	21:24	5:43	15:59	C	13:23	20:15	4:12		E				
LC	E	16:27	0:43	5:27	14:04	E	14:47	19:49	3:27	11:26	E	7:15	13:54	4:29		E				
LC	E	16:30	0:53	5:40	13:38	E	14:32	22:16	6:21	18:53	C	16:49	20:40	1:51		E				
LC	E	16:30	0:22	6:22	14:48	C	15:10	22:25	5:35	19:42	C	18:07	22:13	2:06		E				
LC	E	16:45	0:43	5:33	13:15	E	13:58	21:03	5:25	16:37	E	13:40	20:40	4:05		E				
LC	E	16:55	0:36	5:07	13:21	E	13:57	22:08	5:55	12:50	E	10:58	17:30	4:27		E				
LC	E	17:15	23:40	4:30	14:35	E	14:15	21:30	5:35	10:00	E	7:30	19:22	8:43		E				
LC	E	20:10	22:42	3:17	15:53	M	14:35	22:42	6:07	15:53	M	14:35	20:25	2:50		E				
R	E	5:45	18:20	7:43	11:45	E	6:05	14:55	5:30	21:03	E	12:58	20:50	4:20		E				
R	E	6:14	13:16	3:19	17:02	E	5:48	15:51	7:07	12:46	C	4:07	18:22	5:47		E				
R	E	6:14	13:16	3:19	17:02	E	5:48	13:16	3:26	17:02	E	5:48	15:40	5:03	13:54	E	5:04	14:50	4:02	E
R	E	7:50	16:05	5:39	13:30	E	5:35	15:45	7:04	13:56	E	5:41	19:42	6:59		E				
R	E	7:50	16:05	5:21	12:36	E	5:41	13:03	4:36		E									
R	E	8:19	20:03	7:29	10:44	C	6:17	20:50	7:41		E									
R	E	8:19	20:03	7:29	10:44	C	6:17	18:13	5:20		E									
R	E	9:05	18:55	4:49	9:59	E	5:54	13:25	4:45	16:40	E	6:05	17:48	6:44		E				
R	E	9:25	15:25	2:50	20:00	E	11:25	20:53	5:31	11:10	E	8:03	20:56	7:20	10:41	E	7:37	18:20	7:13	E
R	E	9:30	20:53	6:06	11:17	E	8:10	18:20	6:04		E									
R	E	11:10	23:40	7:47	13:21	E	13:01	23:40	5:40	13:21	E	13:01	22:21	5:14	12:59	E	11:20	20:57	5:55	E
R	E	11:12	22:34	7:50	9:56	C	8:30	20:27	7:12		E									
R	E	12:28	18:47	6:11	9:56	C	8:00	20:27	7:12		E									
RP	M	6:30	20:15	6:09	10:15	M	6:30	17:18	7:05		M									
RP	M	6:30	21:07	7:44	10:28	M	7:35	21:02	6:20	8:58	P	6:00	18:03	5:33	12:42	C	6:45	15:32	6:53	M
RP	M	6:30	21:06	7:42	10:29	M	7:35	21:06	7:53	10:29	M	7:35	22:52	6:04	8:48	C	7:40	14:05	5:08	M
RP	E	7:20	18:37	7:47	10:38	E	5:15	9:02	2:29	19:23	C	4:25	11:52	4:04		E				
RP	E	7:45	21:58	7:37	10:02	E	8:00	17:39	5:00	12:56	E	6:35	20:10	7:04	9:15	E	5:25	11:54	3:53	E
RP	M	8:10	21:10	6:05	8:45	P	5:55	14:00	4:42		M									
RP	E	9:55	22:45	6:47	13:20	E	12:05	23:46	7:20	14:44	E	14:30	23:51	5:19	13:24	E	13:15	19:33	4:01	E
RP	E	10:48	21:23	5:13	8:52	C	5:15	17:41	5:14	11:34	E	5:15	16:58	7:57		E				
RP	E	12:03	22:02	7:09	20:08	C	18:10	23:01	3:05	12:39	C	11:40	21:33	4:46		E				
RP	M	12:30	21:00	3:26	9:10	P	6:10	21:04	6:17	10:43	M	7:50	20:49	6:17	9:36	M	6:25	15:25	5:25	M

Appendix 4. Scheduling Assistant Models for Potential Use

Models and Tools for Effective Fatigue Measurement are described in: '*Proceedings of the Fatigue and Performance Modeling Workshop'*, Neri D. & Nunnely S. (eds.), *Avition, Space and Environmental Medicine*, 75(3), Section II (Supplement), March 2004.

Different bio-mathematical models of fatigue, sleepiness and performance are available for potential use by flight attendants. The development of the models started when Borbely (1982) modeled the sleep-wake cycles as a two-process system described as a combination of a homeostatic and circadian influence. According to Borbely, there is a sleep-regulating variable that increases during wakefulness and decreases exponentially during sleep. The two-process model became the most accepted and validated of the models, and all follow-on models are based on it. Models, however, differ in the number of factors that are included. For example some of the models include the effect of sleep inertia effect (the groggy, sleepy, and perhaps disoriented feeling after waking from deep sleep, which lowers performance for the first few hours after awakening), some models estimate the light levels and the corresponding effect on the phase shifting of the circadian clock, and yet other models include the effects of drugs. They also differ in the representation of the underlying curves that describe the attenuation of performance while awake and replenishment of performance while asleep, and an oscillating curve representing the circadian effect on performance. For example, the models are represented using linear, exponential, polynomial and sigmoid curves.

The following is a list of the most accepted models and tools, including a very short description of each:

1. The <u>Two-process Model</u> (Achermann, 2004) is based on the assumption that there is a linear interaction between a sleep/wake dependent homeostatic Process S and a circadian Process C that generates the timing of sleep and waking. The time course of the homeostatic variable S was derived from EEG slow-wave activity and the Process C was driven by the endogenous circadian pacemaker located in the suprachiasmatic nuclei (SCN) in the hypothalamus. The Process S rises during waking and declines during sleep. The model allows both the simulation of the timing of sleep and waking, and of sleepiness and alertness. From the sleep and wake times, and the light levels the person experiences, the model generates circadian phase, alertness ratings and fatigue scores.
2. The <u>Sleep/Wake Predictor Model</u> (Akerstedt, Folkland, and Portin, 2004) has three components: a process S which is an exponential function representing the time since awakening, a process C which represents sleepiness due to circadian influences and has a sinusoidal form with an afternoon peak, and a process W or sleep inertia. Therefore, the model is based on the assumption of an exponential fall of alertness during wakefulness, an exponential rise of alertness during sleep, a circadian rhythm of alertness with a peak at 16:48, and an exponential sleep inertia factor. From the work shift times, the model generates sleep times, alertness ratings, reaction time, sleep latencies, vigilance performance, and lane drifting performance measures in 5-minute intervals.
3. The <u>System for Aircrew Fatigue Evaluation (SAFE)</u> (Belyavin and Spencer, 2004) is a program used to assess the fatigue implications of aircrew schedules and uses the QuinetiQ alertness model. The model contains two main components: one related to the effects of the preceeding pattern of sleep and wakefulness, the other to the circadian rhythm. From the pilot work shift times, locations, number of pilot crewmembers, and the availability of a bunk in the aircraft, the model generates alertness ratings. The program also provides an estimate of the extent of the circadian adaptation to any time-zone transitions, as well as the timing that has been assumed for sleep.
4. The <u>Interactive Neurobehavioral Model</u> (Jewett and Kronauer, 1999) is based on the linear combination of a circadian component, a homeostat and sleep inertia component, which determine the neurobehavioral performance. The circadian component is determined by the output of a circadian pacemaker affected by light and the level of the homeostat (declines in a sigmoidal manner during wake and recovers in a saturating exponential manner during sleep). Sleep inertia occurs at scheduled wake time and declines in

saturating exponential manner. From the work shift times, the light levels experienced by the person, and the time allotted to sleep, the model generates circadian phase, alertness ratings, and cognitive throughput measures.

5. The Fatigue Audit InterDyne (FAID) (Roach, Fletcher, and Dawson, 2004) is a software-based audit system that assesses the potential and/or actual hours of work (i.e., start/end times of work periods) to determine the level of work-related fatigue. The model is based on the assumption that the fatigue level is determined by the balance between fatigue caused by work periods and recovery obtained in non-work periods. The fatigue and recovery values depend on their length, circadian timing, and recent history (i.e., previous seven days). An essential capability of the model is that it can be linked to an organization's schedule engine such that the fatigue levels can be determined in real-time for any schedule of work. From the work shift times, the model generates continuous fatigue scores, and violations of risk threshold levels.

6. The Circadian Alertness Simulator (CAS) Model (Moore-Ede, Heitmann, Guttkuhn, Trutschel, Aguirre, and Croke, 2004) is based on the assumption of a superposition of the homeostatic and circadian process. The homeostatic component is assumed to have an exponential increase during sleep and an exponential decrease during wakefulness while the circadian component is assumed to have a sinusoidal function with a 24-h period and additional higher harmonics. One of the important features of the software is a training module that makes availability of the model to specific populations (e.g., employees in certain occupations). From the work shift times, the model generates sleep times, alertness ratings and fatigue scores.

7. The Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) Model (Hursh, Redmond, Johnson, Thorne, Belenky, Balkin, Strom, Miller, and Eddy, 2004) is based on the assumption that there are three components: a sleep reservoir, circadian rhythm, and sleep inertia that combine additively. The sleep reservoir involves sleep-dependent processes that control the capacity to perform cognitive work. Sufficient sleep time fills the sleep reservoir, and hours of wakefulness deplete the reservoir. The sleep accumulation process is influenced by sleep intensity (which is affected by existing sleep debt and circadian factors) and quality of sleep (which is affected by sleep continuity). Cognitive effectiveness (the output) is predicted based on the level of the sleep reservoir and the time of day (circadian phase), as well as on the influence of sleep inertia. From the sleep and wake times, and the quality of the sleep, the model generates performance effectiveness models.

The following describes one model and an associated tool in a little bit more detail, which also provide examples of ongoing research activities within the FAA:

The Fatigue Avoidance Scheduling Tool (FAST) is a fatigue assessment tool for Microsoft® Windows® based upon the SAFTE model and it was developed for U.S. Army and U.S. Air Force. It predicts the effectiveness of humans based on the amount of sleep and it allows users to determine the best schedule to avoid fatigue. It takes into account sleep deprivation, sleep schedules, and circadian variation to determine the effects on human effectiveness. Schedulers and planners can estimate the average effects of various schedules on human performance and further determine the best sleep schedule to avoid fatigue. The software requires as input work and/or sleep schedules or actigraphic sleep estimation data. When high levels of fatigue cannot be avoided, FAST predicts these times and allows leaders to take additional risk management measures. The software interface provides the schedule input and the output predictions in graphical and tabular formats; it also provides tables of estimated effectiveness scores for objective comparisons. A mission timeline is available for flight operations. All screens may be copied to the clipboard and pasted into Excel or Power Point. FAST has various commercial applications. For example it can be used as a safety and accident investigation tool, as a training tool, and to predict performance for various work schedules (Hursh et al., 2004).

Appendix 5. Three Models Selected for This Experiment

Three models were selected for this experiment and included: the Two-process model (Achermann, 2004), the Astronaut Scheduling Assistant model (ASA; Van Dongen, 2004), and the Fatigue Avoidance Scheduling Tool model (FAST™; Hursh et al., 2004). The Two-process model was chosen because it is a classic tool and the foundation for the other models. The ASA and FAST™ were selected because they are two of the more sophisticated models currently in existence.

The Two-process Model (Achermann, 2004) is based on the assumption that there is a linear interaction between a sleep/wake dependent homeostatic Process S and a circadian Process C that generates the timing of sleep and waking. The time course of the homeostatic variable S is derived from EEG slow-wave activity and the Process C, is driven by the endogenous circadian pacemaker located in the suprachiasmatic nuclei (SCN) in the hypothalamus. The Process S rises during waking and declines during sleep. The model allows both the simulation of the timing of sleep and waking, and of sleepiness and alertness. Based on the sleep and wake times, the model generates circadian phase and alertness ratings.

The Astronaut Scheduling Assistant model (ASA; Van Dongen, 2004) is a computer software tool, being developed in collaboration with the NASA-ARC/Fatigue Countermeasures Group to predict changes in astronauts' neurobehavioral performance during space missions. The ASA model builds on the Two-process Model by utilizing equations for a limit cycle oscillator to predict circadian rhythms in response to light levels. Additionally, the model includes the chronic modulating process to account for short-term changes in performance due to sleep homeostatic changes during sleep and wake as well as the long-term changes occurring during chronic sleep restriction and recovery sleep. The ASA generates alertness ratings using some of the same input variables as the Two-process Model but with algorithmic differences to emphasize the consequences of chronic sleep restriction and provides a basis for addressing the impact on individuals. A graphical user interface is available to input schedules and view alertness predictions. Additionally, a DOS command-line program is available to generate text files containing the alertness predictions, which can be viewed using Microsoft® Excel. The ASA is available for Microsoft® Windows®.

The Fatigue Avoidance Scheduling Tool (FAST™) is a fatigue assessment tool for Microsoft® Windows® based upon the SAFTE™ model (Hursh et al., 2004) and was developed for the U.S. Army and U.S. Air Force. It is directed toward predicting the effectiveness of humans based on the amount of sleep and allowing users to identify schedules to avoid fatigue. It takes into account sleep deprivation, sleep schedules, and circadian variations. Software input requires work and/or sleep schedules or actigraphic sleep estimation data. The software interface provides the schedule input and the output predictions in graphical and tabular formats; it also provides tables of estimated effectiveness scores for objective comparisons, and a mission timeline is available for flight operations.

A significant difference between the FAST™ and the other two models is that FAST™ makes an assumption that sleep occurs during time available for sleep. The other two models estimate sleep based on a number of factors that include circadian-based readiness to sleep. Table 7 provides an overview description of the models.

Table 7. Overview of Models Used.

Model	Design Purpose	Model Description	Inputs	Outputs
Two-process Model	To investigate and test hypotheses about sleep regulation	Uses a linear interaction between the sleep homeostat and circadian processes and includes a sleep inertia module	Bedtimes (from which sleep is calculated), wake times	Sleepiness ratings
Astronaut Scheduling Assistant (ASA)	To predict changes in astronauts' neurobehavioral performance	Uses a sleep homeostat and a limit-cycle circadian oscillator to predict the timing and duration of sleep. Includes sleep inertia and chronic sleep loss components	Bedtimes (from which sleep is calculated), wake times, lighting	Sleepiness ratings
Fatigue Avoidance Scheduling Tool (FAST™)	To provide military planners a fatigue assessment tool for improving performance during conditions of limited sleep	Based on the SAFTE™ model which additively combines a sleep reservoir, circadian rhythm and sleep inertia modules	Work and/or sleep schedule information or actigraph sleep estimation data. Provides "auto-sleep" algorithm (capability to automatically estimate sleep)	Graphs and tables of estimated effectiveness and summary statistics.

Appendix 6. Model Results

For the purpose of this report and to obtain a meaningful evaluation, certain basic assumptions needed to be made to input the flight attendant schedules in the various models. First, sleep/wake schedules were unavailable; therefore, a 90-minute buffer was placed before and after each duty period to provide time for transportation, meals, and preparation for sleep or duty. We do not know how representative this buffer period is. It is obviously longer than the period assumed by the CFRs. However, since our intention was only to see if the models could handle this kind of scheduling information it was necessary to make some assumption and, based on information supplied concerning flight attendant activities, the 90 minute pre/post buffer did not seem unreasonable.

All off-duty time, minus the buffer periods, was assumed time in bed. All models have the ability to automatically calculate sleep; this calculation was utilized for the Two-process and ASA models. The FAST™ model's auto sleep function allows commute time to be entered in one-hour intervals; however, this did not allow for the 90-minute buffer period. Therefore, sleep was automatically calculated and then manually adjusted to maintain the 90-minute commute time and limit sleep to a maximum of eight hours.

The second assumption dealt with light levels. For the Two-process and ASA models levels were assumed to be 150 lux during scheduled work hours and 0 lux otherwise (i.e., asleep or in bed). For the FAST™ model, light levels were not incorporated. Finally, without knowing previous work and sleep histories, it was assumed that each schedule began in a stable, rested state, defined with the model defaults settings, which are sleeping from midnight to 08:00 for the Two-process and ASA models and sleeping from 22:00 to 06:00 for the FAST™ model. The FAST™ model provides a phase shifting function that was enabled. This function incorporates the effects of time zone changes on the circadian rhythm, which is not included in the Two-process or ASA models.

A graphic representation of the example schedules used is given in Figure 1.

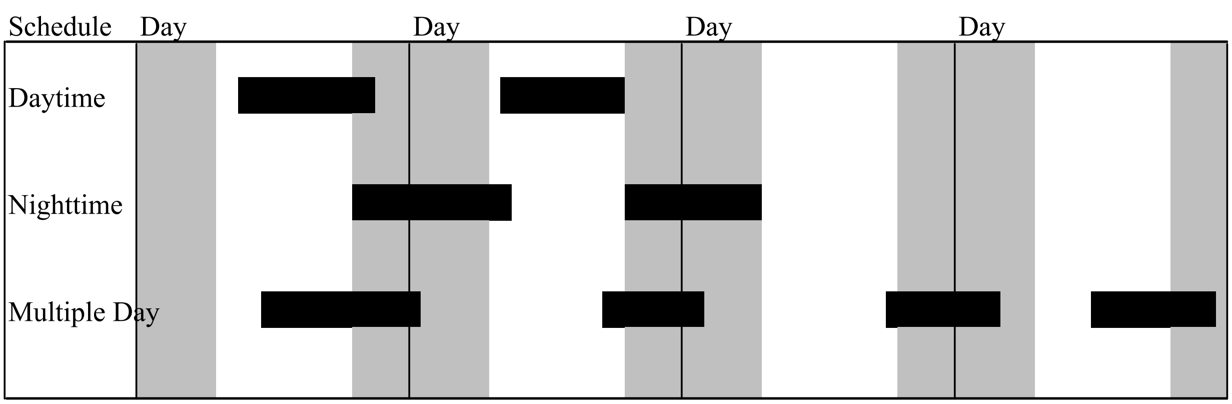


Figure 1. Graphic Representation of Example Schedules (The white columns indicate daytime, the grey columns nighttime, and the black bars duty times.)

A. Description of the Three Example Schedules

Daytime Schedule Example

Following is an example of a schedule that represents daytime operations (see Table 8A). Again, as with all of the schedules, it is assumed that a flight attendant would begin the schedule in a stable, rested state.

Table 8A. Example of Daytime Schedule

DAY	Departure Time Zone	Duty Start	Arrival Time Zone	Duty End	Duty Hours
1	Eastern	09:30	Eastern	20:53	11 hr 23 min
2	Eastern	08:10	Eastern	18:20	10 hr 10 min

Note. Local start times presented

Time awake for the first duty day was between 14 and 15 hours. Sleep for the subsequent night was predicted between seven and eight hours (see Table 8B). Again, note that here, as in the following examples, the results presented may or may not reflect actual sleep time for these schedules. They are examples of what the models can do with the information provided. Given the schedules used and the information assumed, this schedule is an example of a schedule that is predicted to produce relatively low levels of sleepiness and few dips in effectiveness in comparison to other schedules examined.

Table 8B. Predicted Sleep for the Daytime Schedule Example (BASED ON THE STATED ASSUMPTIONS)

DAY	Layover Time	Two-Process Model Predicted Sleep	ASA Model Predicted Sleep	FAST™ Model Sleep
1	11 hr 17 min	7 hr 40 min	7 hr 18 min	8 hr

Nighttime Schedule Example

Following is an example of a nighttime schedule thought to produce higher levels of fatigue in comparison to the daytime schedule (see Table 9A). Note that since both duty periods are during the night, sleep must occur during the day, which resulted in shorter predicted sleep time (see Table 9B). For the second duty period, factors such as recent sleep and time of day are predicted to contribute to lower levels of effectiveness and higher levels of sleepiness.

Table 9A. Example of Nighttime Schedule

DAY	Departure Time Zone	Duty Start	Arrival Time Zone	Duty End	Duty Hours
1	Central	19:10	Eastern	08:01	12 hr 51 min
2	Eastern	18:30	Central	06:17	11 hr 47 min

Note. Local start times presented.

Table 9B. Predicted Sleep for the Nighttime Schedule Example (BASED ON THE STATED ASSUMPTIONS)

DAY	Layover Time	Two-Process Model Predicted Sleep	ASA Model Predicted Sleep	FAST™ Model Sleep
1	10 hr 29 min	5 hr 16 min	4 hr 24 min	7 hr 29 min

Multi-day Schedule Example

Below is a four-day schedule from a domestic carrier (see Table 10A). Table 10B provides the layover time as well as the predicted sleep time by model. Note that calculations for the third sleep opportunity indicate that not enough time is available to provide for adequate rest. Additional factors affecting the predicted sleepiness and effectiveness levels for this schedule include time of day (arrival time late night/early morning), hours awake (awake over 17 hours on day 3), and recent sleep and previous sleep (sleep debt building according to Two-process and ASA models).

Table 10A. Example of a Multi-day Schedule

DAY	Time Zone	Duty Start	Time Zone	Duty End	Duty Hours
1	Central	12:45	Mountain	00:29	11 hr 44 min
2	Mountain	16:45	Central	01:33	8 hr 48 min
3	Central	18:52	Central	04:18	9 hr 26 min
4	Central	12:18	Central	23:12	10 hr 54 min

Note. Local start times presented.

Table 10B. Sleep Opportunity for the Multi-day Schedule Example (BASED ON THE STATED ASSUMPTIONS)

DAY	Layover Time	Two-Process Model Predicted Sleep	ASA Model Predicted Sleep	FAST™ Model Sleep
1	16 hr 16 min	6 hr 17 min	6 hr 24 min	8 hr
2	17 hr 19 min	5 hr 43 min	6 hr 18 min	8 hr
3	8 hr	4 hr 31 min	4 hr 54 min	5 hr

B. Results from Each Model Examined

Below are graphs of the predicted model outcomes for each model. Relative steepness of slope indicates increased sleepiness predicted during duty time. Higher placement on the Y axis suggests a higher going-in level of fatigue. (These models have not been validated and all conclusions must be considered tentative.) The Two-process and ASA models produce sleepiness scores, where an increase on the Y-axis denotes an increase in sleepiness. For the FAST™ model, an effectiveness score is produced, where a decrease in the score denotes an increase in performance. NOTE: The scale on the FAST™ model graphs shown below have been inverted for ease of viewing with the other models. Cumulative clock time starts on day one of the schedule at 00:00. Sleep times within the cumulative hours are indicated in black/gray on the x-axis. For the Two-Process and the ASA models, the arrows on the y-axis indicate the direction of sleepiness. For the FAST™ model, the arrows on the y-axis indicate the direction of effectiveness.

Two-Process Model

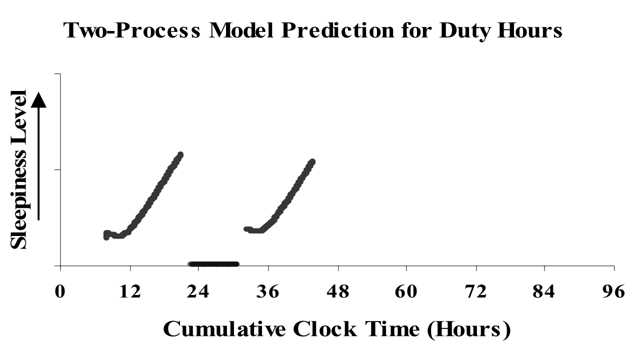


Figure 2A: Day-time schedule

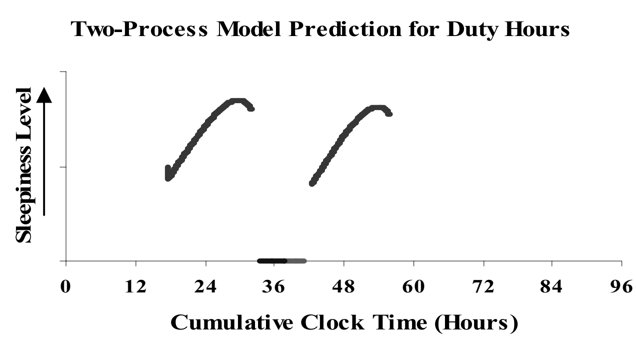
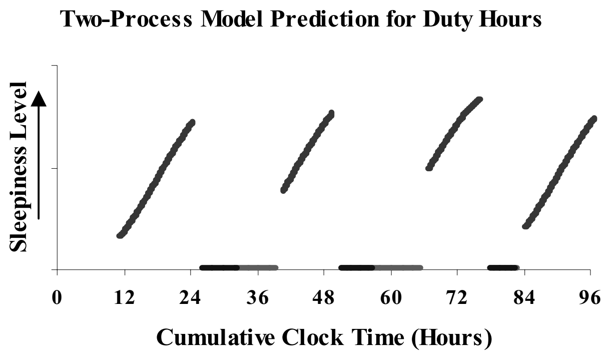
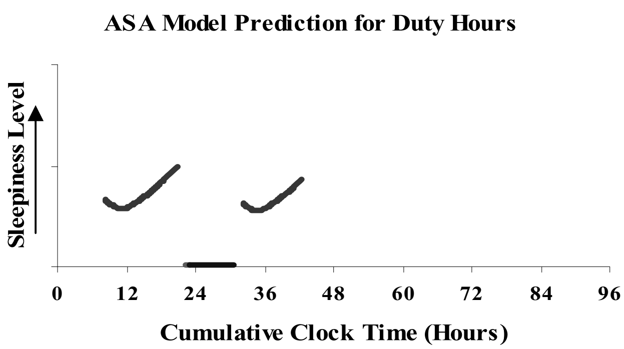


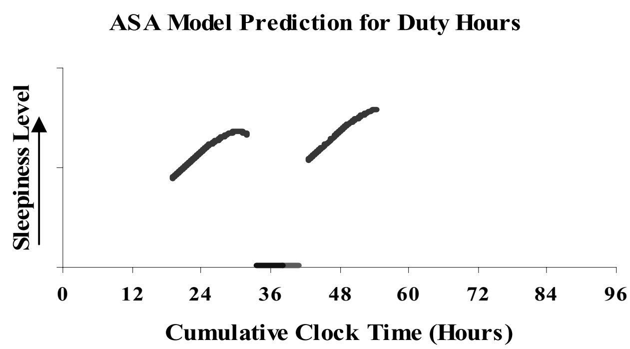
Figure 2B: Nighttime schedule

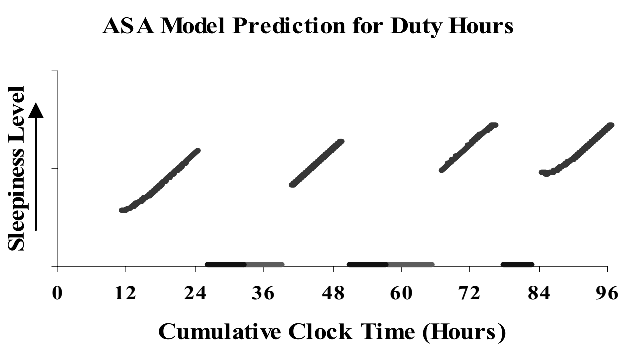


For the Two process Model, the nighttime flight appears to show the most sleepiness while there is little indication of consistent change between and across days for any of the schedules. Again, sleep opportunity (black/gray) and estimated times (black only) within the cumulative hours are shown on the x-axis.

ASA Model







For the ASA model, the nighttime schedule indicates a higher level of sleepiness, while the multi-day model suggests there may be a higher level of fatigue as the duty days, progress. It is important to understand that the alertness (inverse of sleepiness) estimates produced for the Two-process and ASA

models are best interpreted relative to some kind of optimum performance, meaning that at this point, the results should be interpreted based on changes in scores over time and not numerically.

SAFTE™/FAST™ Model

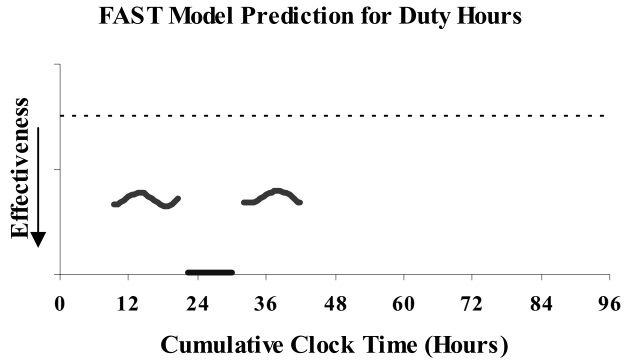


Figure 4A: Daytime Schedule

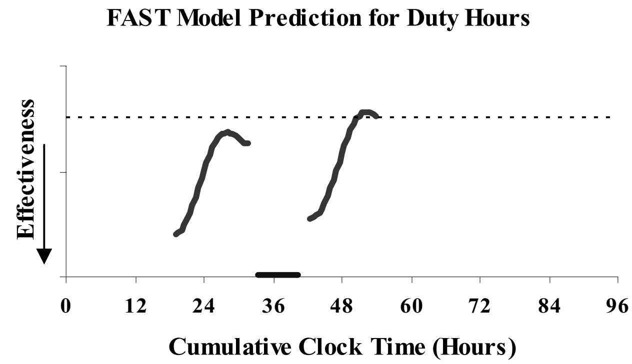


Figure 4B: Nighttime Schedule

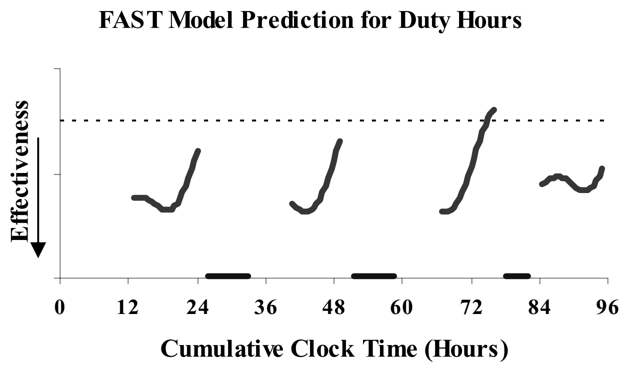


Figure 4C: Multiple-Day Schedule

Figure 4 shows the results for the FAST™ model. The FAST™ model has categorized levels of predicted performance effectiveness (measured as speed of cognitive response). This model employs a color-coding approach in its output to denote levels of effectiveness and is seen on the FAST™ Screen Shots in Appendix 5. The green zone, 90-100% effective, is the range of performance of a fully rested person and the yellow zone (65-95%) is the range of performance of a person during the 24-hr period after missing a night of sleep, indicating that fatigue countermeasures should be used. The red zone (below 65%) is the performance range following two nights of sleep deprivation, indicating a level that is unacceptable for operations. (For a visual of the FAST™ output, see Appendix 6).

Notice that with the current example the effectiveness level for the daytime schedule never drops below 90% suggesting that performance should be in normal range of a well-rested person during the duty hours. For the nighttime model, the lowest percent efficiency is predicted at 73% during the early morning hours on the second duty day. This is below the default criterion level (77.5%), which represents the performance of a person during the day following loss of an entire night's sleep. Reduced recent sleep and time of duty day are two factors contributing to the increased fatigue from this schedule in comparison to the daytime schedule. For the multi-day model, performance will enter the yellow zone of below 90% effectiveness at some point during each of the duty days and will be less than 77.5% (the criterion line) nearing the end of the third duty day. The FAST™ model of this schedule suggests the added pressure on alertness that may occur with extended trips.